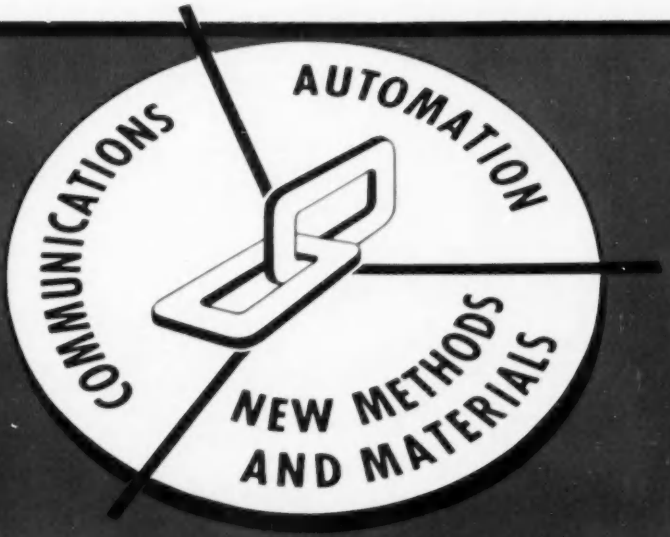
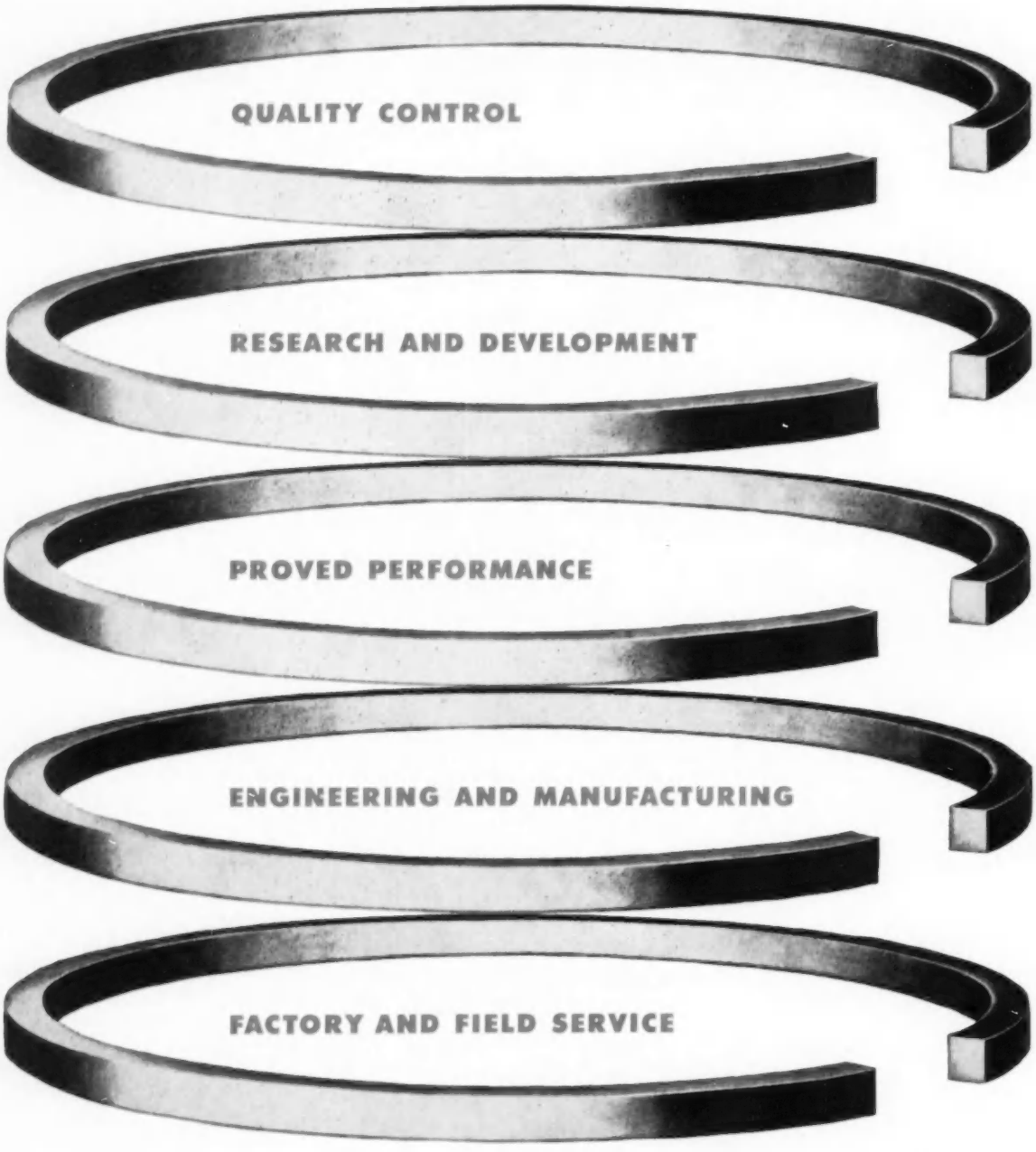
SAE Journal

ANNUAL PRODUCTION ISSUE



MAY 1955

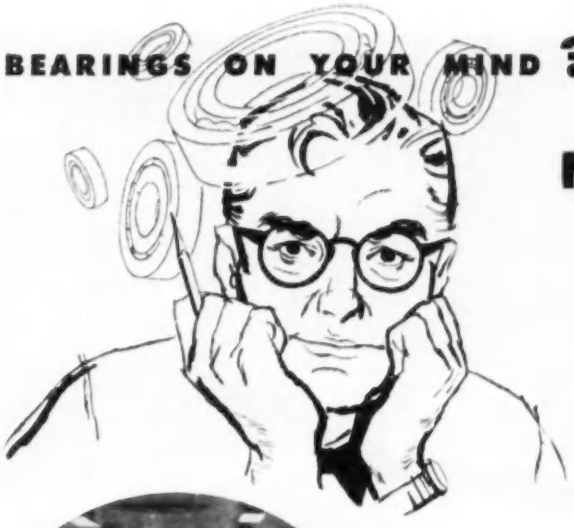
Published by The Society of Automotive Engineers



These are five important reasons for the *overwhelming* preference for Perfect Circles. And, 35 out of 37 manufacturers using chrome rings specify **Perfect Circle** piston rings!

Perfect Circle Corporation, Hagerstown, Indiana; The Perfect Circle Co., Ltd., Toronto, Ontario

BEARINGS ON YOUR MIND ?___ CALL ON NEW DEPARTURE PDQ*!



* QUALITY

Batteries of automatic torque testers check all bearings where very low starting torque characteristics are specified. The vast amount of research and development behind these machines is another guarantee to you of unfailing quality from New Departure.

* PRICE

High volume and ultra-precision go hand in hand at New Departure. In the grinding area of the instrument bearing plant, with its filtered air and controlled humidity, the finest, most modern machines assure close tolerances with quantity production.

* DELIVERY

A large staff of skilled workers move with precision in air-conditioned surroundings to meet the heavy demand for instrument bearings. Here, painstaking assembly and inspection operations are keyed to high delivery schedules.

PLUS ENGINEERING SERVICE

New Departure field offices are strategically located across the country. You will find a staff of experienced sales engineers in your area. Call for help on any problem of ball bearing selection or application. You'll get real service . . . PDQ!

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NOTHING ROLLS LIKE A BALL

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RIGHT FOR THE JOB!

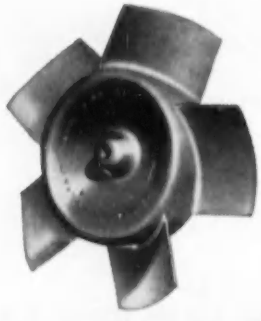
Before you specify *any* heater for your new truck models, be sure it's designed to deliver the BTU's needed to do the job *right*. A custom-built Evans heater will do the job *right* because it's designed to meet these special heating and engineering requirements of *your* trucks: size and design of cab . . . glass area . . . amount, type and placement of insulation and all other related factors.

Evans heater components, such as heavy duty motors, strong one-piece alloy fans and sturdy fin and tube type cores are perfectly balanced in design for *extra* performance and *longer* life. What's more, an Evans heater offers low-cost maintenance and easier service because it's built to fit your truck.

Each Evans heater has a parts "repair or replace" warranty for one year or 50,000 miles, whichever occurs first.

You'll benefit, especially in that important stage of designing a new model, by calling in Evans' engineers to work hand in hand with you. They'll design the right heater for *your* job, build the prototypes and test them to your complete satisfaction.

For free copy of new catalog, write: Evans Products Company, Dept. Z-5, Plymouth, Michigan.



This is the exclusive, one-piece EVANAIR fan

. . . never loses its shape or balance. Precision die-cast in one piece. It doesn't chip, crack or bend, has no parts to work loose. It's light . . . less than half the weight of ordinary fans, yet delivers more air with less vibration and motor wear!

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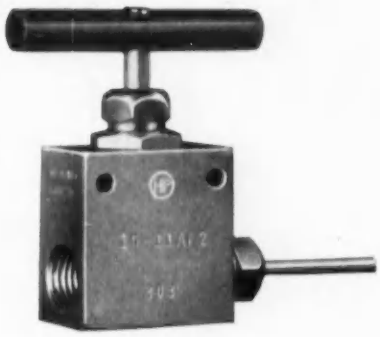
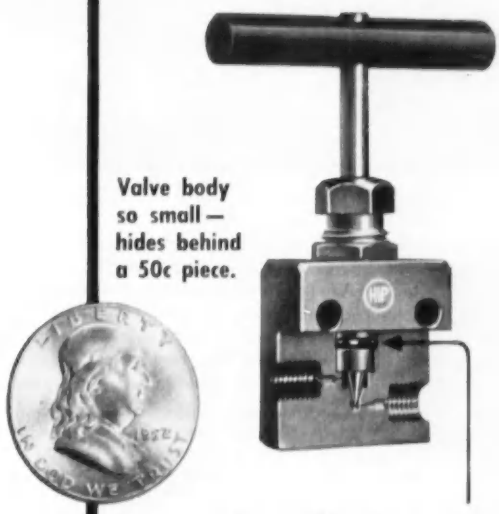
Precision "O" Ring holds 15 tons pressure in this HIP Midget Valve!



ACTUAL SIZE!

Versatile and compact Needle Valves, by High Pressure Equipment Company, Erie, Pa., use **Precision "O" Rings** to do the vital sealing job which keeps these midgets leak-proof. Pressures—0 to 30,000 PSI!

Precision "O" Rings—always quality controlled, tough, compression molded—your assurance of top, trouble-free performance. Let our engineers help solve **your** sealing problems with the finest "O" Rings made!



Valve body so small—hides behind a 50c piece.

PRECISION "O" RING

FREE—Write for your personal copy of our Handbook on "O" Rings.

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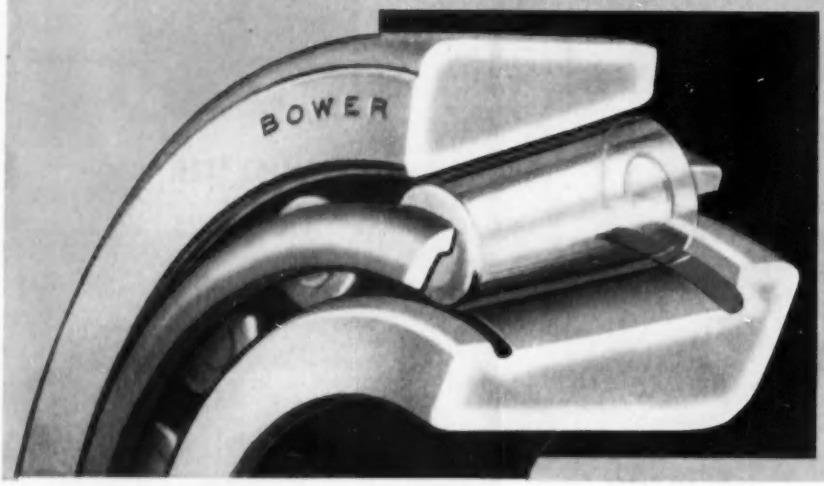
Bower spher-o-honed design provides better bearing lubrication



LARGE OIL GROOVE GIVES POSITIVE LUBRICATION TO ROLLER HEADS

The large oil groove built into Bower Spher-O-Honed bearings is just *one* of several important Bower design features which reduce maintenance and increase efficiency. Combine it with generated spherical roll-heads and a higher flange surface, and smooth, precision-honed races, and you have the basic elements of Spher-O-Honed design.

A careful look at the illustration above will show you other important Bower features, too. Note particularly that the roller heads contact the flange over a wide two-zone area—thus reducing wear and minimizing resultant "end play."

Built of the highest quality materials and workmanship, Bower bearings are available in a complete range of sizes and types to meet your present requirements. Call in a Bower engineer now!

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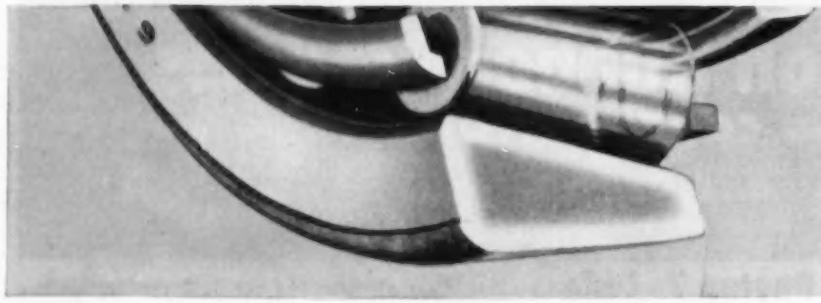
BOWER

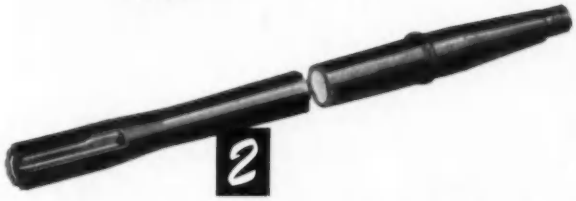
ROLLER BEARINGS



A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS

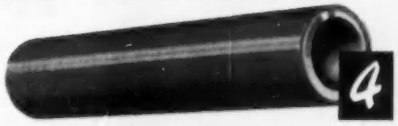
7 WAYS to SAVE MONEY with TOCCO* Induction Hardening

Cost was reduced 94% when heat-treatment of this corn-harvester part was changed from carburizing to TOCCO-hardening, 9½c saved on every piece — $4750 on each 50,000 piece batch, plus an hourly production increase from 120 to 300 pieces per hour.



$375 per day! When Salisbury Axle switched to TOCCO-hardening axle shafts. Less machining—30 seconds instead of 2 minutes—means lower tool cost. Also production zoomed from 50 to 120 per hour. TOCCO hardened shafts have 200% greater torsional life.

Kearney & Trecker Corp. reduced the cost of hardening this milling machine part from $1.57 to 10c apiece. In addition TOCCO made possible a switch from alloy to S.A.E. 1045 steel—saving another 11c per piece in material cost. Kearney & Trecker hardens 140 different parts on one TOCCO unit.



Thompson Products Ltd. boosted production of these automotive wrist pins from 500 to 1200 per hour when they switched to TOCCO-hardening. Costs fell from $5.45 to $3.25 per hundred parts—a savings of 2c per pin, $26.40 per production hour.

Mechanics Universal Joint Division of Borg-Warner reports a 69% savings in the hardening of stub ends for propeller shafts. TOCCO also upped production from 35 to 112 parts per hour—over three times as fast as conventional heating methods.

Lima-Hamilton Corporation adopted TOCCO for hardening this shifting lever. Results: a savings of 4c per piece—$25 per production hour. TOCCO costs only 17% of former heating method. This is only 1 of 139 parts TOCCO-hardened by Lima-Hamilton Corp. All show savings over usual heating methods.

7 Number 7—the lucky number—is up to you. Why not add your name to the list of companies who use TOCCO Induction Heating to increase production, improve products and lower costs. TOCCO engineers are ready to survey your plant for similar cost-saving results—without obligation, of course.

THE OHIO CRANKSHAFT COMPANY

TOCCO

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Please send copy of "Typical Results of TOCCO Induction Hardening and Heat Treating."

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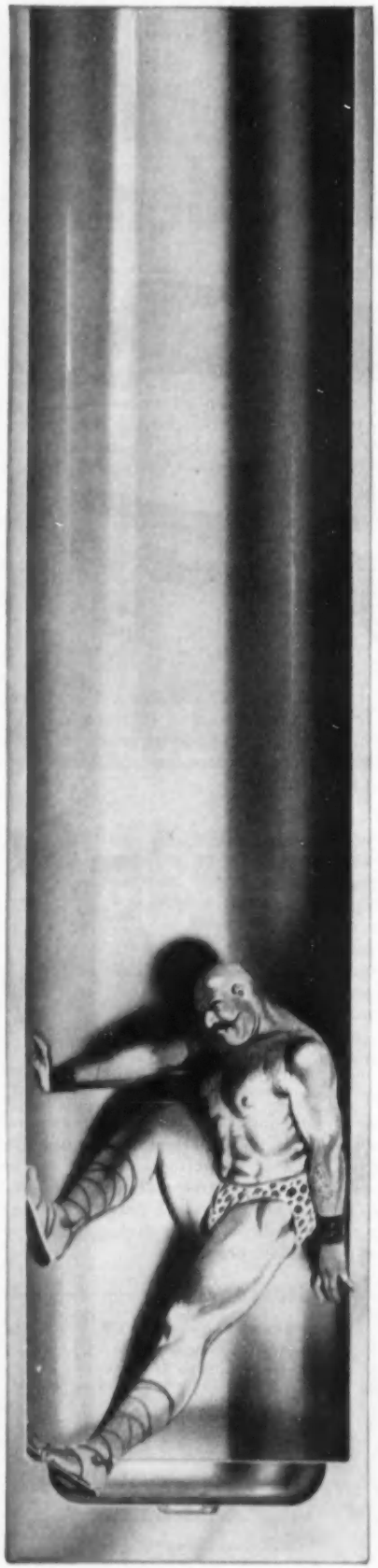

Could you wrap up 3000 psi a BETTER way ?

• The Mullins *Koldflo** Process *cold extrudes* this accumulator shell, which operates at 3000 psi, and withstands 12,000 psi burst pressure. For high-pressure service in hydraulic starting systems, this one-piece design is ideal. It eliminates assembly of forgings and tubing required with conventional designs, eliminates an O-ring seal as well.

Extruded with integral end to finished dimensions, *Koldflo* accumulator shells can wrap up *your* pressure problems better—and at less cost! If you require precision cylindrical steel parts in high volume, give us your specifications, and quantity required. We'll be glad to show you how *Koldflo* can turn your new designs into new and better products.

Mullins Koldflo extrudes this 4½" diameter accumulator shell in one piece. These extrusions can be furnished in a variety of shapes and sizes and with a choice of mechanical properties. Tolerances are extremely close as made. Surface finish measures 60 RMS or better, depending on shape.

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"How would you tool-up to make an egg?" For copy of informative new booklet, write Koldflo Division, Dept. K-5 Mullins Manufacturing Corporation, Warren, Ohio.

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Warren, Ohio

Phone: 2-1166

LITTLE THINGS MEAN A LOT—

in upping pay loads, too

Exclusive Goodyear Bond-a-Coat finish resists corrosion and discoloration, keeps its luster indefinitely.

MAYBE you've never thought of rims as a big item in your operation. Yet, you can achieve big savings if you pick the right rims.

Goodyear Wide Base Rims, for example, in nearly all sizes, weigh less than standard-size wide base rims. *When you specify these lighter rims, you can haul as much as a hundred pounds' extra pay load on a tractor-trailer unit.*

Greater Tire Mileage

In addition, Goodyear Wide Base Rims give up to 30% greater tire mileage—and the service records of countless trucks and buses prove it. That's because these superior rims help to reduce sidewall flexing—resulting in less tire heat, fewer tire failures and road delays.

Cost Less To Start With

And here's the real pay-off: *even their initial cost is lower!* Check the whole story on these important economies with your Goodyear Rim Supplier. Or write Goodyear, Metal Products Division, Akron 16, Ohio

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WIDE BASE RIMS

MORE TONS ARE CARRIED ON GOODYEAR RIMS THAN ON ANY OTHER KIND

We think you'll like "THE GREATEST STORY EVER TOLD"—every Sunday—ABC Radio Network—THE GOODYEAR TELEVISION PLAYHOUSE—every other Sunday—NBC TV Network

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BOOST...

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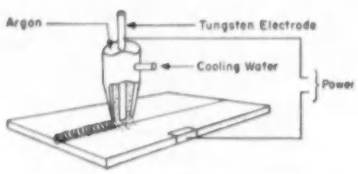
Whatever your fabricating needs—in small shops or on production lines, on carbon steel, complex alloys or non-ferrous materials —LINDE has a high-speed, cost-saving electric welding process for every job. Here is the line-up of this top-notch team . . .



HELIARC Welding—*ideal for metals .020 in. and thicker* . . . Joins all commercial metals in easy operations—attains speeds over 100 inches per minute . . . Welding is done in all positions on all types of joints with portable manual, semi-automatic, and mechanized equipment.

There is no slag, spatter, or smoke—the operator can see and control the weld puddle at all times. Weld finishing is seldom necessary, and investment and maintenance costs are low.

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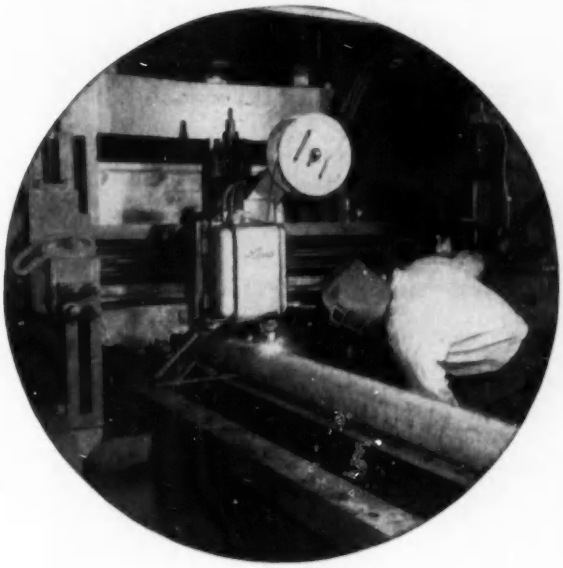
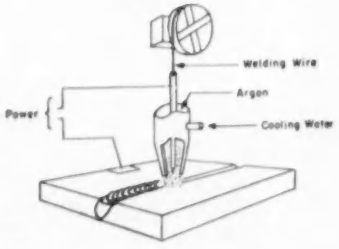
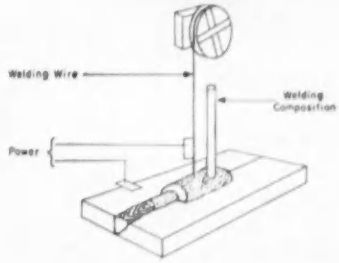
For Joining Metals.....







Sigma Welding—*4 times faster wire deposition than by manual rod feed methods . . .* Full penetration up to ¼-in. in a single pass . . . Joins all commercial metals —and attains speeds of more than 100 inches per minute on many operations.

Uses any d.c., or c.p. (constant potential) power supply. With c.p., an operator has only to set the wire feed rate—current remains essentially constant throughout welding. Both manual and automatic mechanized sigma welding equipment is easy to operate and maintain.

UNIONMELT Welding—*joins metal of any thickness . . . Up to 3-in. thick in one pass.* Extreme depth of penetration and high rate of wire feed make this the fastest and usually the most economical of all welding processes. Deep penetration or wide shallow beads are easily attained by UNIONMELT welding.

Both portable manual and mechanized setups are available, and can use any a.c., d.c., or c.p. (constant potential) power supply. With c.p., no control is necessary to maintain constant arc voltage throughout welding.

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Ask for Form 7942, "Modern Methods of Joining Metals."

Enjay now foremost butyl rubber supplier

90,000 tons yearly production of Enjay Butyl, now available from its originators, will go into varied industrial products

Enjay Company, Inc., a pioneer and leading supplier of petroleum chemicals, will market Butyl and supply advisory service in its applications.

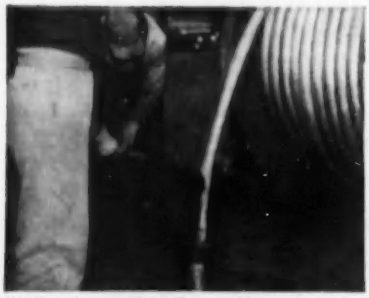
The low price and high-level performance of Enjay Butyl allow it to replace natural and other rubbers now used in industry. Enjay Butyl is the rubber that combines high resistance to aging . . . abrasion . . . tear . . . chipping or cracking . . . ozone or corona . . . chemicals and gases . . . heat . . . cold . . . sunlight . . . and moisture.

The new Enjay Laboratories, located at Linden, New Jersey, are equipped to provide expert technical assistance in compounding and adapting Enjay Butyl to individual uses and requirements.

Distinctive properties and low price give Enjay Butyl wide industrial application

Inner tubes are made of BUTYL because BUTYL holds air ten times better than natural rubber. Its impermeability to gases promises many uses.

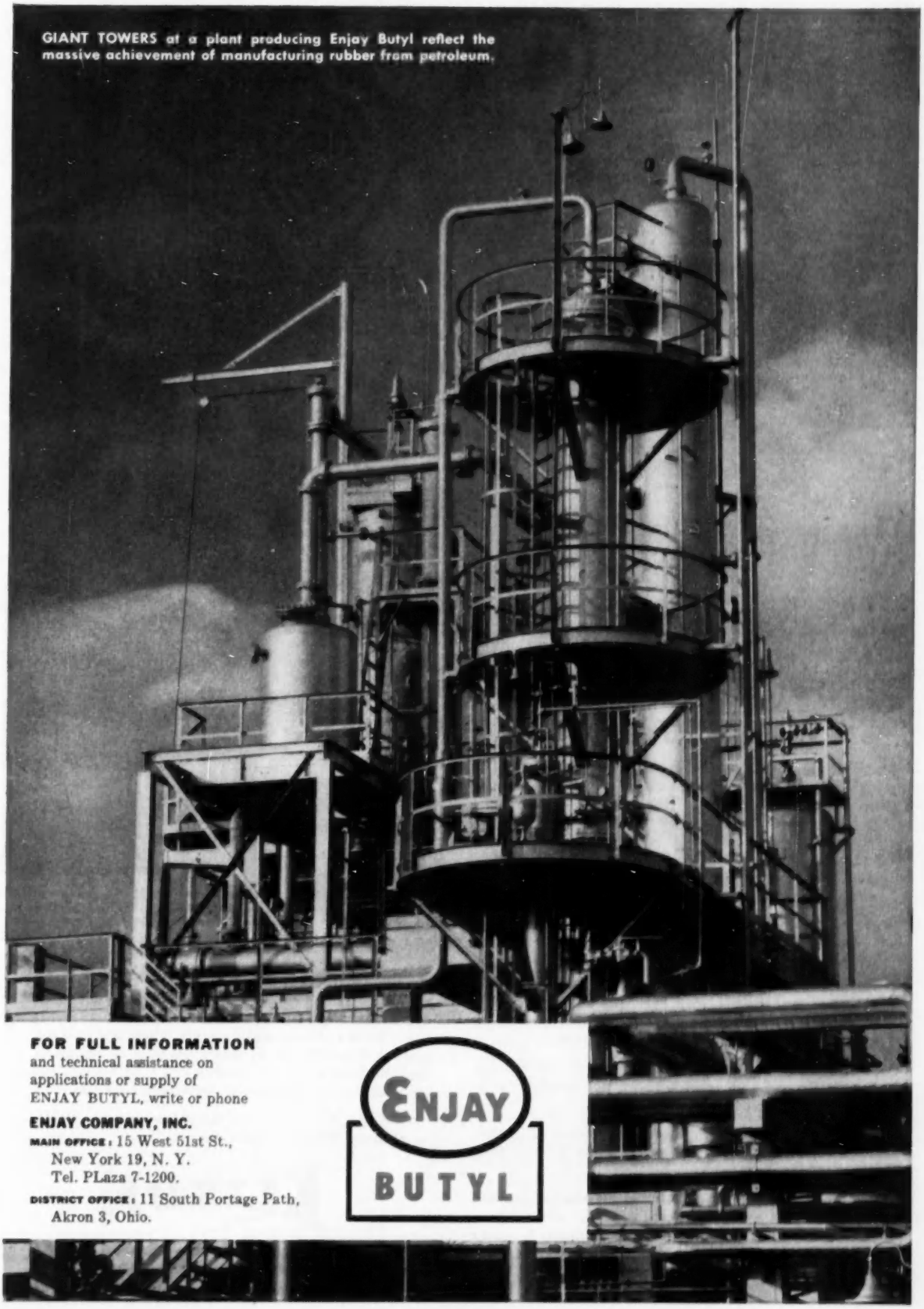
1955 cars use Butyl for dozens of rubber parts, because BUTYL has super-durable resistance to aging or deterioration on exposure to heat, cold, sun, weather, and chemicals.



High voltage electrical cables are made with BUTYL because BUTYL offers superior corona and ozone resistance, combined with excellent heat, cold, and abrasion resistance.

Tractor tires are made with BUTYL because BUTYL gives low tread wear and high resistance to weather, cracking, cutting, and chipping.

Protective clothing, tank linings, belt covers, hoses, and other equipment in contact with chemicals use BUTYL because of its exceptional resistance to chemicals.



GIANT TOWERS at a plant producing Enjay Butyl reflect the massive achievement of manufacturing rubber from petroleum.

FOR FULL INFORMATION
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ENJAY
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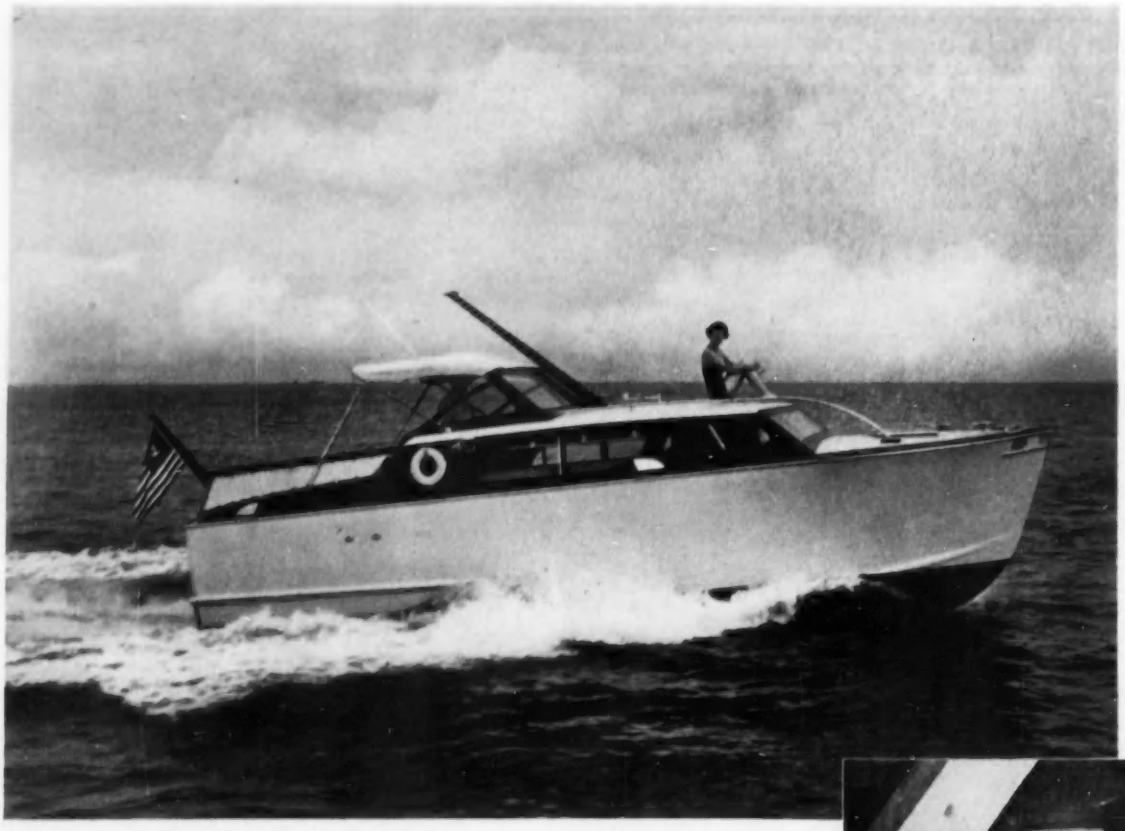

Two Klixon C9121's are used to protect circuits in the 31 ft. Owens express cruiser.

For Safer, Carefree Cruising
OWENS YACHT COMPANY
USES
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CIRCUIT BREAKERS

Illustrated is the Owens 31-foot express model, pace-setter of the Flagship fleet. She features accommodations for six and is available with choice of single or twin marine engine installations.

Since safety is a prime requisite, Owens uses Klixon Circuit Breakers to provide foolproof overload protection in electrical circuits.

Here's what Mr. J. B. Owens, President of Owens Yacht Company, Inc., has to say about Klixon protection.

"Yachtsmen want their boats as foolproof as possible. They also like permanent work and they don't like to carry spares. We use Klixon Circuit Breakers to satisfy these three requirements and give them a better, safer wired boat."

Klixon Circuit Breakers are small, compact, easy to install. They provide protection against shorts or overloads. They eliminate the nuisance of carrying spare fuses and fuse replacements. Their accurate operation is unaffected by shock, motion or vibration. And they work equally good in 6, 12, or 24 volt systems in marine, automotive, or aircraft applications.

Consider Klixon Circuit Breakers for your mobile equipment. Write for information.

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For the Sake of Argument

Stature . . .

By Norman G. Shidle

Most jobs take on the stature of the men who fill them.

A big job rarely stays big under the thumb of a small man. And the woods are full of examples of little jobs whose stature grew to that of the man who occupied them. When a man pours himself out into a job, it is natural that the job should begin to look like the man.

Sometimes only separation of the man from the job reveals which it was that had the stature.

We know one executive whose magic touch put successively three public service organizations on the top rung of the importance ladder in the United States. Reflecting men of lesser vision, each job sank quickly to mediocrity when he moved along to the next. . . . We know another who chose a job which traditionally had consisted of successful putting together of routines. It had no prestige to convey. Two years later, it was the second most important job in the small organization of which it was a part.

Big men are rarely held back by little jobs. They have a way of going somewhere and dragging the job along with them. They seem never to be aware of limitations. Perhaps because they see so many opportunities.

The small man too often sees his job analysis sheet as an insulating shell, protecting him from added responsibilities or obligations. He seeks inner security from an ever-present alibi for "keeping his nose out of other people's business." He wants to feel safe from having too much expected of him.

Some, in other words, see a job analysis as an instruction sheet; to others it is merely a carrier from which to take off. This latter group aims for the lasting inner security which is born of accomplishment—and needs no protective shell.

Whatever the individual's attitude toward his job, the job eventually tends to take on the stature of the man who holds it.

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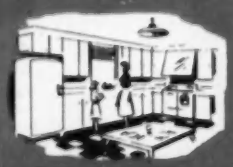
HOME APPLIANCES



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Provide Silent Hydraulic Power for a Wide Range of Applications

Eaton Pumps provide hydraulic power or vacuum for an almost endless list of applications. Outstanding characteristics are compact design, silent operation, high mechanical and volumetric efficiency at all speeds, and competitive cost. Millions of Eaton Pumps are in use today in leading motor cars, trucks, tractors, aircraft, and appliances. Eaton engineers will welcome the opportunity to discuss the application of Eaton Pumps to your products.

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Norman G. Shidle
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29 West 39 Street
New York 18, N. Y.
Tel.: LOngacre 5-7170

W. W. Milne
Western Advertising Manager
7530 Sheridan Road
Chicago 26, Illinois
Tel.: AMbassador 2-7091

A. J. Underwood
Midwestern Advertising Manager
3-210 General Motors Building
Detroit 2, Michigan
Tel.: TRinity 2-0606

SAE DETROIT OFFICE
R. C. Sackett, Staff Representative
808 New Center Bldg.
Tel.: TRinity 5-7495

SAE WESTERN BRANCH OFFICE
E. W. Rentz, Jr.
West Coast Manager
Petroleum Bldg.
714 West Olympic Blvd.
Los Angeles 15, Calif.
Tel.: Prospect 6559

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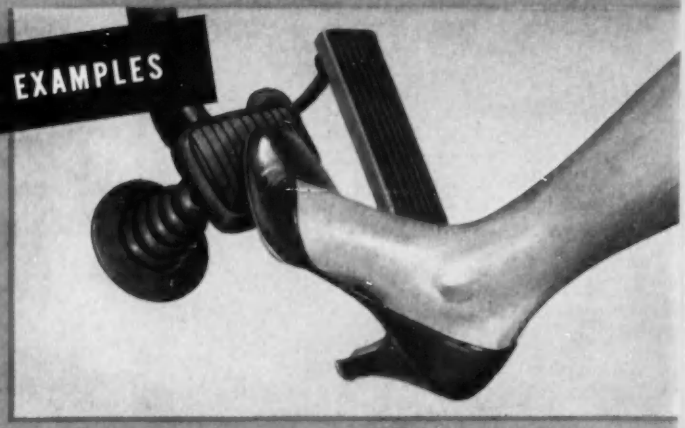

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Today's Three Major Production Problems . . .

. . . are the focus of this issue.

1. AUTOMATION . . . what it is, when and where you consider it, how you apply it.

2. COMMUNICATIONS . . . between production and design engineers . . . how to improve it.

3. NEW MATERIALS AND METHODS . . . their impact on tomorrow's production.

Members of the SAE Production Activity Committee—thought-leaders in automotive and aeronautic manufacturing—agree that the major emphasis in the production job ahead will be in these areas.

In the article starting on the next page these men tell you why.

Other articles in this issue reveal progress being made toward solution of these problems.

1. Automation
2. Communications
3. New Materials and Methods

The Three-Way Challenge

1. Automation

Paul A. Miller
SAE Vice-President for Production
General Manufacturing Manager
Parts and Equipment Mfg. Division
Ford Motor Co.

Obsolescence a Danger . . .

Obsolescence can be one of the major pitfalls in many automation applications.

Programs have been established to increase automation in our industrial empires but, comparatively speaking, few programs have been established to prevent the obsolescence of such expensive installations. The approach to this problem can only be obtained through intimate relationship and constant liaison between the Product Engineer, Master Mechanic, Design Engineer, Styling Activities, and Metallurgists.

The SAE Production Activity Committee recognizes the potentials that automation holds and is aware of the voids in knowledge and pitfalls of application that many manufacturers must be aware of to prevent obsolescence on automation installations. Because of this knowledge, we feel that the SAE is suited to throw light on automation problems.

Flexibility the Keynote . . .

Systems of automation are being studied and prepared. Flexibility of design is a keynote so that automation will ultimately be employed to some degree in low production industries as well as our great mass producers.

The search for an ever higher standard of living

Carl L. Hecker
First Vice-President
The Oliver Corp.

for all Americans, coupled with a demand for more quality and precision being built in our products, has resulted in this new "system" of production which we call "automation."

Greater output per man hour, improved quality, elimination of danger and fatigue from workers' lives will result from automatic processing of parts and finished products, material, and even data controlling the product design and processing.

Col. M. P. Jolley
Vice-President and General Manager
Canadian Acme Screw & Gear, Ltd.

Automatic Screw Machine the Start . . .

Development of the automatic screw machine, some 70 years ago, was a most dramatic step toward automation. One man, with three or four machines, replaced 20 or 25 lathes with an operator on each. Yet without the automatic screw machine, countless

to Production Men

In these pages members of the SAE Production Activity Committee individually express their views about the impact of these problems on future manufacturing operations. All three problems are currently being studied by the Committee.

jobs created through production of low cost articles would never have developed.

It is reasonable to expect that recent and continuing strides in the use of automatic machines and apparatus will create expanded and new fields of low cost items, with resultant gain in employment and standard of living.

A. B. Hegner,
Production Manager,
Fairchild Engine Division,
Fairchild Engine & Airplane Corp.

Three Are the Key . . .

To achieve a higher degree of automation, management, labor, and the engineer must work and live together.

- *Management* must see its advantages clearly enough to spend the money it costs.
- *Labor* must realize that new skills obtained will result in a higher standard of living.
- *Engineers*—both product design and manufacturing—must appreciate the problems in processing that automation creates. Arbitrary prerogatives of engineers in both groups must be tempered and eliminated to prevent mass obsolescence before complete amortization.

Communications Important . . .

To make automation a success and to get full benefits from new manufacturing methods and materials, production-design communications become a very important part of the program.

N. P. Petersen
President
Canadian Acme Screw & Gear, Ltd.

It's not always possible to have perfect communications between the design group, the methods engineers, and the production executives. Top management must recognize and accept the responsibility of informing the team of all the factors related to the problem.

It's becoming clearer that the methods engineer is the connecting link between the product designer and the production group. The better diplomat he is, the better the results will be.

K. W. Stalker
Aircraft Gas Turbine Division
General Electric Co.

Demands More Skilled People . . .

The present-day conception of automation is a continuing development. It is the replacement of human effort with mechanical facilities. Mechanization began with the invention of the wheel. Tech-

nical progress will continue to be developed until there will be factories where all manufacturing processes are mechanized.

The result will be an even greater demand for skilled and professional personnel to operate the complex facility. The technological advances will continue to create an ever increasing number of middle class workers that are the bulwark of democracy. Karl Marx failed in forecasting this important economic trend.

2. Production-Design Communications

T. L. Swansen
Vice-President in Charge of Manufacturing
Ladish Co.

SAE—A Communication Tool . . .

Modern industry is based upon ever increasing technical specialization. The results of pure science are integrated into the applied science of the product designer and the creator of the manufacturing process that produces the products.

When the designer and producer freely exchange ideas, both can make their maximum contribution.

Industry has not provided clear channels of communication for this purpose, with the result that waste is reducing our national effectiveness.

SAE membership has long included these product designers, and more recently, the producers. Therefore, it is ideally suited to develop the lines of communication, and the vocabulary and symbols to make these communications most effective.

B. A. Willsey
Manager, Manufacturing Division
Solar Aircraft Co.

Costs Can Be Cut . . .

Neither design nor production is autonomous. To maintain engineering progress it is necessary to recognize the broad area of common ground between initial design concept and final production plan, where design engineer and production engineer collaborate extensively. Their interests are not incompatible, since they both relate to the common goal of a quality product built at a profit.

Design changes, whether required by the Design Group or the Production Departments, are costly. Each one eliminated through careful pre-planning, by designers in conjunction with Production Engineers, is justification for the investment in improved communication between Production and Design Engineers.

F. L. Zirbes
Superintendent of Assembly Operations
Cleveland Engine Plant, Ford Motor Co.

Just Good Dollars Sense . . .

In these days of specialized machinery, automation, and keen competition, the old song of engineering of "We'll engineer it, you build it" no longer can be sung. Engineering changes can be extremely costly and can sometimes mean the difference between profit and loss unless they are closely coordinated with manufacturing.

The most successful approach to efficient changing has been to establish production contact people in producing areas or resident engineers in manufacturing plants. They are close to the problems and become familiar with manufacturing methods and prevent product engineering from making costly design errors.

E. H. Kelley
General Manufacturing Manager
Chevrolet Motor Division, GMC

Liaison Engineers Bridge Gap . . .

Rapidly increasing complexities in Design and Production necessitate better and faster communications between both. Competent, alert production engineers (liaison group), qualified in both areas, seems to provide the best way to quickly and effectively:

1. Acquaint Design with Production's adaptability and limitations.
2. Inform Production of Design's objectives.
3. Advantageously reconcile requirements of both.

Better knowledge of the functions of detail parts in assemblies by Production, and greater knowledge and appreciation of production problems, including assembly and costs, by Design is required.

Qualified production engineers, if given proper latitude, can quickly and advantageously reconcile requirements of both Design and Production.

L. W. Conrad
Vice-President in Charge of Manufacturing
The Heil Co.

More Knowledgeable Production Men . . .

Complete and active communication between the designer and the production people is more important today than ever before.

It is no longer sufficient for the production people to be only good mechanics or good tool designers, they must also be represented by top flight engineers who can correctly analyze the product designer's requirements, and design production facilities to produce products which will meet these requirements economically.

In our plant we are developing manufacturing engineers for each product division, with the assignment of working between the product designer and the final assembly floor. They are rapidly improving our end-product result by their ability to understand the designer's requirements and convert it to reality through our planning, tooling, and production divisions.

O. Wiesemann
Production Manager
Caterpillar Tractor Co.

Two-Way Flow . . .

Communication between design and production is the life-line of constructive planning. The long-term view of engineering design and change communicated to the planning engineer establishes a sound basis on which to develop present and future manufacturing facilities.

Communications must flow in both directions. A design engineer with knowledge of manufacturing facilities can design a product to encompass customer desires, yet lend itself to facilities available.

The key is in flexibility of layout, machine tools, and methods of manufacture. This provides the design engineer with a maximum flexibility in design and eliminates a high percentage of obsolescence in manufacturing equipment.

Complexity Emphasizes Need . . .

Good communications between Production and Design are becoming more important every year as the products produced by the automotive industry are becoming more complicated.

To design and produce on an economical basis, each of these new items must be brought into production on a mutually cooperative basis by both manufacturing and engineering. In the past, with a relatively simple line up of product, it might have been possible to tolerate slow communications and something less than complete interchange of information.

Progressive companies have established engineering-production teams to pass on new designs and to influence engineering to create designs that are efficient to produce. Models already in production are re-analyzed to ascertain what mistakes have been made in the past to prevent them in the future.

J. E. Adams
Director of Purchasing & Planning
White Motor Co.

Edward D. Kemble
Consultant, Management Research
Management Consultation Services
General Electric Co.

Empiricism A Drawback . . .

Many of our present design and manufacturing practices are based on purely empirical approaches. Much of the communication between the people involved is, therefore, as much an attempt to specifically limit it to areas of safe practice, as it is to exchange necessary information with regard to the problems associated with products for which they have mutual, but different, responsibilities.

Because of the different backgrounds for the empiricisms of the people, this communication, at times, even approaches a tongue-in-cheek evaluation of its intelligent reception. Many unnecessary delays and extra costs are, therefore, frequently incurred before there has been a real meeting of minds.

Increasing competition is forcing a sharpening up of practices beyond that available from a purely empirical approach.

More and more, therefore, successful organizations are finding that their production and design communication must be based on the underlying "what" and "why" of their industrial requirements. This means that there is a requirement for communication techniques founded more on underlying scientific statements and less on shibboleth of individual past practices. The development and understanding of these techniques is one of the present roadblocks to future progress.

A. H. Fries
Works Manager, Chrysler Corp.

Fabrication a Design Element . . .

The designer and master mechanic must practically live together to benefit from the advantages of semi-automatic and automatic machines with mechanical transfer between operations. The methods of fabrication must be a basic part of the design.

Working together, they can develop a part to fit either existing manufacturing equipment or more advanced types that possibly will be developed by the time the part is ready for production. To coordinate the design of parts with present and future fabrication methods, product development groups have been formed.

Technical specialists of these groups are assigned a full-time job of systematically creating, planning, and executing new designs. These designs are developed to the point where they can be manufactured with great ease, lower cost, and maximum quality, and still meet all requirements demanded by engineers.

E. O. Wirth
Staff Assistant to Group Vice-President
Bendix Aviation Corp.

It Affects Profits . . .

Even in the earliest development stages of a product, the communication between production and design engineers is necessary to eliminate extra costs and production problems. In the automotive field with its tremendous volume, competition is keener than ever and many organizations are recognizing the necessity of improving their product engineering and manufacturing team. If this communication is weak, companies will not be able to compete where the margin of profit is small.

With the scientific advancement in the aviation field, demand for research engineers is great and the shortage of these men, therefore, does not allow them time for training in manufacturing problems.

Management, therefore, can bring about needed improvements through cooperative organization. SAE has contributed much in bringing about coordination between production men and design engineers through its activities.

3. New Materials and Methods

M. L. Frey
Assistant to General Works Manager
Tractor Plants, Allis-Chalmers Mfg. Co.

Future Rich with Promise . . .

The effect on production of the impact of new manufacturing methods and new materials, or more correctly, new forms of existing materials, is often like a chain reaction. One application results not in another but in several others.

How far will this effect progress and what are its implications for the future? No one can say with assurance. And therein lies the need for study and evaluation of the technical as well as the economic aspects.

We need to know more about what can be done with such things as the various methods for producing close tolerance castings, powder metallurgy, new tool materials, recently developed free-cutting steels, and a host of others.

How do they fit into the cost picture and are they worthwhile in any other way for any particular product? Production men have a most important part to play in helping find the answers to such questions.

Emery B. Kerekes
Assistant to the Vice-President
Loewy Construction Co.

Look to Chipless Production . . .

"Chipless production" and "draftless precision forgings" are the watchword of the day. Pennies saved per piece on labor, machining time, and consumption of materials can amount to gigantic dollar values per year in mass production.

Closed die forging not only improves the physical properties of the metal but, with properly designed presses and dies, it is also capable of producing parts which require very little finish-machining. Even brighter lights appeared more recently on the horizon with the current research and development work on draftless, close-tolerance forgings.

Equally intriguing are the possibilities and recent developments in extrusion techniques. Aside from

the greatly improved physical properties and close tolerances, extrusion techniques can produce shapes otherwise impossible to produce by machining.

Latest developments in extruding wide and relatively thin sections, even with integral reinforcements, also the possibility of extruding shapes of variable cross-sections, opened up new avenues for further technological progress.

Considerable attention is given to the possibility of combining extrusion and closed die forging in one integrated operation.

E. W. Bernitt
Vice-President
American Motors Corp.

It's A Company-Wide Responsibility . . .

At American Motors, all departments are charged with the responsibility for promotion of efficiency and quality through the investigation of new materials and methods. In addition, engineering research and manufacturing staff personnel provide the necessary final economic and qualitative analysis.

Considerable benefits are possible and have been obtained through the competitive research and development activities of American Motors' suppliers.

In addition, we recognize that technical societies and associations offer major benefits in this area. We encourage such membership and the active participation of American Motors' personnel.

The constantly improving technology of methods and materials requires that a competitive manufacturer maintain continuing efforts to take fullest advantage of the changing benefits available.

Michael Field
Partner, Metcut Research Associates

Jet Engine Creates Needs . . .

In an amazingly short period of years, we have witnessed a transformation to reality of an incredible array of technological products in such fields as atomic energy, electronics, and gas turbines. Behind the scenes in these accomplishments has been a vast development in materials and in their methods of processing.

In the race for jet engine supremacy, new alloys are needed for higher temperatures, and other metals are required that combine high strength with low weight. Many of the intricate engine components cannot be made by known processing methods, and in most all engine parts there is a need for new methods which will reduce the cost of manufacturing.

The development of manufacturing methods and the search for new material calls for accelerated research in all industry. Required here is first the recognition of such a need, and then expansion of research and development facilities and activities.

D. S. Kimball, Jr.
Vice-President and General Manager
Bendix-Westinghouse Automotive Air Brake Co.

Encourage Imagination . . .

The greatest challenge in history to the production engineer is in the creation of new methods of manufacture and substitution of newer materials. Managements today must encourage production engineers to use their full imagination in meeting these basic requirements.

In meeting today's intensive competition for present and future markets there are three basic requirements: (1) product performance, (2) cost, and (3) selling price. The required performance is a matter of customer demand.

With performance established, it is then up to the production engineer to provide a cost low enough to establish sales prices acceptable to the customer and equitable to the manufacturer.

Anderson Ashburn
Special Projects Editor
American Machinist

Keeping Abreast of Progress . . .

Developments in both methods and materials have come so rapidly in recent years, the men charged with production are so busy, and the mass of printed matter is so great, that it is a rare production man who can be sure he is keeping up with his field. Yet he must find ways to learn of and evaluate such developments. If he does not, he may fail to do his production job in the best available way, with serious consequences for his company, his product, and himself.

In the SAE Production Activity, we need to use the means we have—such as production forums and panel discussions—and perhaps to develop other, better means, not only to remind us of developments we may have missed, but to retain alert and inquiring minds—minds that will force each of us to the effort needed to sort through the mass of information available, to develop reliable sources, and to find those kernels of development important to us.

WANTED:

Basic Principles

THE word automation, while a common term in engineering and production circles, has recently been bandied about by many uninformed people. As its usage has spread, confusion on the subject and its implications have multiplied.

What's Automation?

What do we as engineers mean by automation? The word automation cannot be found in late issues of the Encyclopedia Britannica. It is not contained in Webster's Unabridged Dictionary published as recently as 1952. Funk and Wagnall's list of new words published in 1953 defines automation as follows: "Process of rendering machines self-active or self-moving, or automatic. Automatic operation, the theory, art, or technique of making a device for industrial process more fully automatic."

Actually, automation is merely a new word applied to continuing technological progress which not only substituted mechanical power for human drudgery but also has been a prime factor in raising our standard of living. It began with the invention of the wheel and has continued ever since. We engineers understand and appreciate this fact. But unfortunately, many other people are being deliberately confused by current publicity under the label "automation."

We should not forget that sound basic engineering and economic principles influenced our past decisions. Because somebody recently hung a fancy label "automation" on technological progress, there is no reason why future decisions should not be based on the same sound considerations.

There is an abundance of literature blithely extolling the merits, and the glories if you will, of automation; reams of literature heralding amazing installations to come; and fantastic prophecies from those who distort facts to sell their product. SAE should lead in the effort to squelch these distortions of the facts.

Currently there is being expended, or invested, by American industry, many millions of dollars annually for special purpose machine tool facilities. Estimates for like expenditures just a few years hence indicate that industry proposes to risk stockholders' money at an accelerating rate. What have we as members of the Society of Automotive Engineers done? What will, and what can we as members of this organization do, to assure that these investments are in reality sound economic investments, and not just plain gambles against long odds?

We should grasp, more readily than any other group, the tremendous responsibility involved in such extraordinary expenditures, and the potential drain on private capital if these expenditures are not wisely made. Therefore, we have the grave responsibility of seeing that the purpose of these expenditures is accomplished successfully and not defeated through ill-advised, expensive, excursions into so-called automation. That obligation primarily devolves upon the individual member of SAE.

How can we proceed to meet this obligation? We find ourselves as the body that should be alerting management, not only to the advantages of new and improved facilities that will assure quality and efficiency, but also to their effect on cost; and how long this expensive equipment will serve its purpose of producing products that are constantly susceptible to change—changes that may seriously threaten the expected amortization period of the facility.

We are concerned that perhaps a few companies, who already have made very substantial investments in new equipment, may soon find that their design engineers, technicians, and production men have not given sufficient consideration to future design changes. If any of our companies should perchance make major capital expenditures for costly

for Automation

E. H. Kelley, General Mfg. Manager, Chevrolet Motor Division, GMC
J. T. Buckmaster, Chevrolet Motor Division, GMC

Excerpts from paper "Urgent Need for Principles of Automation" presented at SAE Golden Anniversary Production Meeting, Cincinnati, March 15, 1955.

new equipment that is not flexible enough to accommodate future design or production changes, then I feel that we members of SAE will have the delicate and unpleasant task of explaining to our managements why we were not alert to our responsibilities.

To prevent such blunders on the part of engineers and production men, and to provide an "opportunity making" environment in which engineers can design and build new and better facilities, more adequate and more adaptable to design changes, we must continue to be guided by sound basic business principles. Let's not forget that because of any new new word that may be applied to our continuing technological advances.

If we, as engineers, do not insist upon applying equally as sound principles in the future as we have applied in reaching our current high point in technical progress—at least in covering the engineering needs of all the functional groups in SAE—we certainly will not be doing our job.

What have the design engineers done to date in exploring and providing for future design changes that may, or will have to be, incorporated in the product and produced on present so-called automatized equipment?

What have they done to alert management to the necessity for developing a more intensive collaborative program with market research engineers, with sales engineers, with the production engineers, with the machinery and equipment design engineers, with building construction engineers, and with accountants? Have they done anything along that line? If so, have they gone as far in this vital collaboration program as is necessary? If they have, what has been their experience? What have they learned? What did they do with that knowledge?

The answers have a very important bearing in the continuing development of our technology for the good of all. It appears that the design engineers bear the responsibility for initiating this necessary group collaboration. They have the knowledge not only of what they are presently designing, but to a great extent, certain probable future design changes. Therefore, the primary responsibility for initiating this urgently needed collaboration program, rests squarely on the design engineers.

But if the design engineers shirk this responsibility that is pre-eminently theirs, then some other group—and perhaps it would be the production engineers—will have to do their job for them.

We would all agree that over the years, the automotive industry has achieved considerable skill in gathering together standard machine tools, conveyors and other equipment supplemented by special machines, and have arranged all of them into efficient mass production facilities. Plant layout is one of the keys to our efficiency. It has become a specialized art requiring the combined skills of the engineer, the accountant, and the three dimensional chess player.

The master mechanic engineer, and the machine

design engineer need not necessarily wait for the product design engineer to initiate the needed group collaboration program. There are certain basic production propositions that the master mechanic and equipment design engineers can and should follow in the interim.

Manufacturing Principles

Based on our accumulated experience in achieving our present level of technological progress, these are economic and production propositions we must keep constantly in mind:

1. Any new process or equipment, call it what you will, should provide maximum protection against what has been termed the minimum hazard principle in production. Therefore, operation sequences shall be combined and set up in a matched and balanced manner so that the least hazard of machine interferences will result.
2. Such installations should provide for extension of the "module" idea to its greatest economic effectiveness. So, the sequence of operations should be set up to provide maximum utilization of basic standardized units of machinery and tooling.
3. The installation should facilitate straight line flows of material with maximum production line compactness.
4. The installation should further provide retention of control of the product material from the earliest point in the process to the final, or to the nearest final stage of completion of the process.
5. Adequate provision for continuity of line operation in the event of intermediate station failure.
6. Provision for production not only of current and anticipated future design but also ample clearance for other tooling to accommodate interchangeability and past model service requirements.

The propositions set up are primarily rules that apply more particularly to the engineers in the Master Mechanic group. It must be conceded that the engineers of the Master Mechanic group have done a rather good job, generally speaking, in complying with these basic propositions not only in the old, but in the new installations made to date.

I said generally speaking, they have complied with these propositions. Unfortunately, the engineers in the Master Mechanic group have no crystal ball or other secret means of detecting the probable design changes, which the product design engineers expect or anticipate may be incorporated in the product at any near or distant future date.

Without this knowledge of future design changes, which only the product design engineers conceive or specify, the Master Mechanic engineer or the Production engineer cannot collaborate with the facility design engineer to ensure that maximum economic adaptability is provided in the proposed new facility. In this area too, the Product Design group must carry out its responsibility to initiate collaboration between the various engineering groups.

Need Peek at Future Designs

It is no longer sufficient that product drawings portray only the current design change. It is essential that the Master Mechanic engineer have, in addition to the current design drawing, what is of equal or greater importance, namely, drawings which show in phantom outline the anticipated or probable future design expectations. Only with this phantom or similar technique will it be possible for the master mechanic engineer to convey to the facility design engineer the flexibility that must necessarily be provided in the proposed facility.

Only then can management have a reasonable degree of confidence in assuming that the capital risk involved in the acquistion of new facilities has substantial justification. Only then can management be assured that next year (or maybe next month) a necessary or desirable design change can be incorporated in the product without incurring heavy financial penalty.

This responsibility definitely lies with the Product Design group. They can no longer shirk the heavy penalty for their failure in this important obligation to their managements. Therefore, let me say again in the plainest language: Unless the product design group follows these basic principles which provide this vitally needed guidance to management, they are derelict in their duty.

It is of prime importance that adequate provision be made for close collaboration between the design engineer, the market research engineer, the sales research engineer, the production engineer, the accountants, and others in the firm who in the past may not have been consulted to the extent that is now necessary. It is obviously necessary that the master mechanic engineer have knowledge not only of the current product change, and of equal and often of more importance, he must have knowledge of the anticipated product change before proceeding on his facility design and procurement program.

The design engineer must also have the benefit of the counsel or recommendations of the research engineer, the sales engineer, and members of management responsible for the major decisions involved in the development and acquisition of new equipment. These basic requirements now demand constant and intimate collaboration between the product design engineer and the sales research group to form the foundation for any economically safe and intelligent approach to future technological progress.

We can hear from the product design group now a swelling chorus: "To so advise the master mechanic engineer or the machine design engineer of contemplated future design changes would, in effect, freeze our future design. We will have none of that." Well, too many of us have been around too long to buy that old wheeze.

May we ask the product design engineers, if intelligent provision is made in the development of new facilities to accommodate your probable future product changes, or is your future design frozen? Is it frozen one-half so much as it would be if costly equipment were procured which soon proved inflexi-

ble and unadaptable to anticipated changes—changes that could have been, or should have been foreseen, if proper research were undertaken prior to submission of your current product design plans?

Because of the ever increasing cost and complexity of new facilities, may we say to the master mechanic engineers and equipment design engineers, you too must apply sound engineering and economic principles in the area of designing and developing new equipment. You must ensure that it will be sufficiently flexible to accommodate, within the realm of sound economics, not only the current and probable future product design changes, but sufficiently adaptable to accommodate the requirements for production of past model service parts.

Industry knows that the members of SAE have the capacity and the ability to successfully solve these problems. And when I say the SAE—in this case, I refer specifically to the Product Design group of the Society of Automotive Engineers. The Product Design group should promptly proceed to meet its obligation to alert management to the present necessity for closer collaboration between the design engineer, the sales and market research groups, and the production and financial groups. This group collaboration is necessary to ensure that they get together on high ground for a good look down the road ahead, before starting on a highly expensive trip on a modern production highway littered with the dangerous traffic hazards of design changes.

Postscripts from Discussion

Yardsticks for Designers

By W. B. Shimer,
DeSoto Division, Chrysler Corp.

We could add some basic principles for the design engineer which would help in automation.

For example:

1. Design for simple operations.
2. Follow basic tool principles.

To illustrate the second point, here are some of the things to remember: It is well to keep operations parallel or at right angles to each other, such as holes pierced in flanges or holes drilled in machined surfaces. Curved surfaces should be of a true radii. Avoid complicated combinations of curves. Parts should be considered for compactness and rigidity. And some flat surfaces should be provided for simplest handling and machining.

Three More Principles

By E. F. Gibian,
Thompson Products, Inc.

Kelley and Buckmaster tell us you can't get automation by management edict, by passing down the order "Automate!"

The six propositions and basic principles they set forth are a timely call for some soul searching and for a critical analysis of the concept of automation.

Perhaps we can add these three additional principles to the six already presented:

1. Wherever economically justifiable, incorporate self-correcting features by means of feedback controls and automatic gaging and checking equipment.

2. Concentrate the control of all functions of the line in as few control points as possible, preferably into *one control point*.

3. Design the facility to allow for quick tool changes and rapid maintenance to ensure full utilization of the equipment.

A Case in Point

By C. B. Leach,
Pontiac Division, GMC

Certainly a large part of the responsibility on automation should be accepted by the product design engineer. We believe that in many instances he has assumed it.

For example, in tooling the new Pontiac V-8 engine with the high degree of automation planned, the complete engine design and all its major parts were discussed with the Master Mechanics group in the light of possible future design changes, at least two years before the preliminary engineering release for tools. This preliminary release for tools was made four years ahead of scheduled production.

Product engineering planning in this case took into account such factors as:

1. Possible future increases in both bore and stroke.

2. Possible compression ratio increases up to 12.5 to 1, which could use future fuels not then known, or now, as regards commercial availability.

3. Many novel design features which would provide valve cooling, crankcase ventilation, major casting simplifications, and so forth, far in excess of 1955 competitive requirements.

All of these items were encompassed with the least change in the proposed machine tools.

The degree of flexibility in automation which machine tool planning must allow is inversely proportional to the flexibility provided through product design. For instance, if the cylinder block as well as the crankshaft must be redesigned to increase the stroke ⅛ in., then plan for less automation for these parts.

If there is any crystal ball through which all future design variations can be integrated into a clear-cut picture, it has not yet fallen into the hands of the product design engineer.

Automation Brings

SAFETY, speed, space savings, and quality—these are the four main advantages automation offers to the management of the modern factory. They are the benefits that justify the high initial cost of automation.

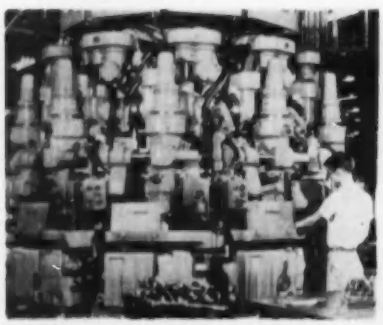
To those who work in the factory, automation offers better jobs and, almost certainly, more of them.

Most important to both management and workers is the saving of life and limbs. Automation is the greatest boon to industrial safety in the history of the industrial age. Take press plants, for example. In an automated plant, all draw presses are equipped with automatic feeding and ejecting devices so that it is never necessary for the operator to place his hands in the press. Operators working on modern trimming dies no longer need to reach into the dies to clean out the scrap. Mechanical production aids take the scrap out of the dies and through the floor to conveyors that carry the scrap to a basement bailer.

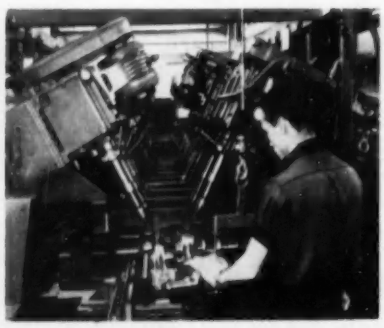
Safety is not only a matter of flesh and blood—although this is the most important consideration. Reduction in the number and severity of accidents reduces the cost of workmen's compensation and the amount of lost time. Furthermore, if your firm gains a reputation for operating safe plants, workers will be attracted to your company and will want to work for you.

Fast production, where machines are able to use up to 90% of their rated capacity through the use of mechanical production aids that transfer parts as fast as the machines can operate, is another economic aspect of automation. The faster the production, the faster the amortization on the machines.

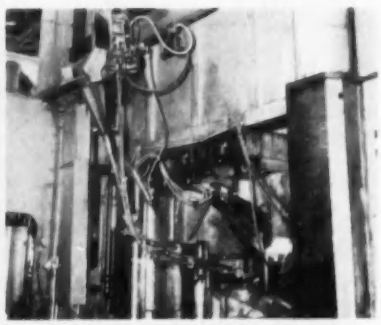
AUTOMATION IS the process whereby a part is automatically carried through a series of manufacturing operations, either in one complex machine or through a series of machines. Basically there are three types of automation machinery: (1) rotary index machines, (2) straight-line transfer-type machines, and (3) mechanical production aids such as electronic switches, conveyors, elevators, loaders, turn-over machines, chutes, and mechanical hands.



1. ROTARY INDEX MACHINE at Chrysler's Indianapolis plant cuts splines of reaction shafts for PowerFlite transmissions. Part rotates from station to station on this 10-spindle gear shaper and emerges completed at the point where it started



2. STRAIGHT-LINE TRANSFER MACHINE shown here is a 30-station multiple-spindle drilling machine. It drills oil holes in the crankshafts of DeSoto engines as the crankshafts progress along from station to station without handling by the operators



3. MECHANICAL PRODUCTION AID is exemplified by this mechanical hand which removes formed parts from a draw press at Chrysler Corp.'s Nine Mile press plant. There's no need for press operators to reach their hands into the press

Safety
Speed
Space Savings
Quality

William Newberg, President, Dodge Division, Chrysler Corp.

Excerpts from paper "The Economics of Automation" presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 11, 1955.

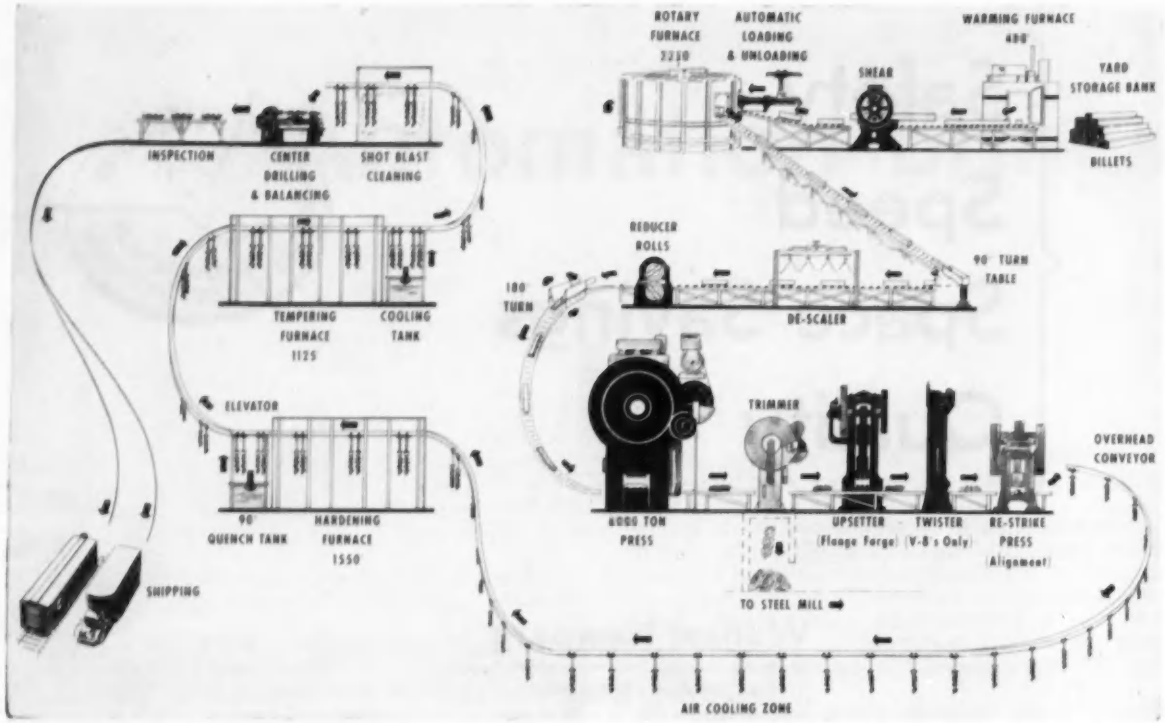
It should be mentioned, too, that this increase in the rate of production is accomplished without increasing the work load of the machine operator. On the contrary, the actual physical labor of the operator is becoming easier and easier through the use of automatic transfer machines, mechanical production aids, and automatic control panels.

Here's an example: In certain press operations it is often necessary for the operator to swab every blank or every sixth or tenth blank with drawing compound. This used to be an extra chore for the operator. Dies requiring blanks swabbed with drawing compound are now equipped—at least at Chrysler Corp. plants—with automatic spray guns that apply a fine spray to the points where it is needed on the blanks. Not only does this speed up operation and reduce the labor of the operator, but the amount of compound used has been reduced 75%. The wives of press operators are happy about this invention too. Their husbands no longer carry home the swabbing compound they have spilled on their shoes and track it in the house. Housekeeping is made easier for both the housewife and the factory.

Automation's savings in floor space can sometimes be startling. Using an automated line, we at Dodge are now building 2400 V-8 engines a day in the same area that we formerly occupied in building 1500 six-cylinder engines a day. This means that not only are we making 900 more engines a day, but for each of these we are making eight pistons, eight pins, and eight connecting rods, instead of the six of each of these that we formerly made. We are also making two cylinder heads instead of one. In addition, we are making a number of parts that we did not use in the six-cylinder engine, such as overhead valves, rocker arms, rocker arm shafts, and hydraulic tappets. This operation is a good illustration of the space efficiences and cost reductions that may be gained through automation.

The superior quality obtainable through the use

SAFE WAY TO BALE SCRAP is to do it automatically and have operator control operation remotely. At Chrysler Corp.'s Nine Mile press plant, this man automatically bales scrap, then loads it on a conveyor that takes the bales to a gondola car waiting outside the plant. The operator watches loading on his television set to see that the gondola is loaded evenly and efficiently



AUTOMATION TURNS OUT CRANKSHAFTS TWICE AS FAST as they were produced under the old system. Automatic processes take steel beams from the storage yard, cut them into billets, preheat and deliver them at proper forging heat to three of the largest mechanical forge presses ever built. Throughout subsequent continuous trimming, straightening, heat-treating, cleaning, and center drilling the operation is highly automated

of automated equipment has always seemed to us at Chrysler Corp. to be a most appealing reason for using automation. There is no doubt that when a part is machined or stamped or assembled automatically by a machine that knows only one way to do its work, the end product is more uniform and higher overall standards of quality can be maintained.

In this competitive age, and particularly in this highly competitive year of 1955, companies must not, and cannot, expect to get by with old standards of quality. The times call for progressively higher standards that will make your product, and every screw and bolt going into your product, better and better.

The improved quality resulting from automation may be the deciding factor that will make the cost of installing automation the best single investment that a company could possibly make.

Automation gives workers a better, more productive life. Not only are jobs better, but the results from our work have made the lives of all of us easier, cleaner, more interesting, and more full of the good things of life.

Today, progress comes to us in the form of automation. It has been a continuing development over the past 20 years. The man who says that automation will not or should not be allowed to work will soon be as outdated and as comical a figure as the men and boys who used to shout, "Get a horse," to the early motorists.

It is a basic rule of industry, proved over and over again, that more efficient production means more jobs.

For example, 50 years ago there were about 800 shops where carriages and buggies were made. Today there is but one small company that still makes horse-drawn carriages and buggies exclusively. Did thousands of people lose their jobs? No, thousands of people changed to better jobs, and many thousands more were added to the employment rolls of the new automobile industry. Today, Chrysler Corp. alone employs more than twice as many people as were employed 50 years ago in the manufacturing of horse-drawn carriages and railroad equipment combined. The only ones to lose their jobs were the horses.

Whether we are for it or against it, automation is here and it is here to stay.

It behooves each of us to look about and see what effects these changes in the factory will have on us. First of all it means that we must be willing to adjust ourselves to new ways of doing things and new ways of thinking about production problems and to accept the opportunities that they offer. We must make our adjustments quickly. If we fall behind, we will find our places taken by others with more foresight and greater adaptability, just as any company—certainly any automobile company—must adapt and change and invent or become a relic.

The worker in automotive plants today has an unparalleled opportunity to raise his paycheck by

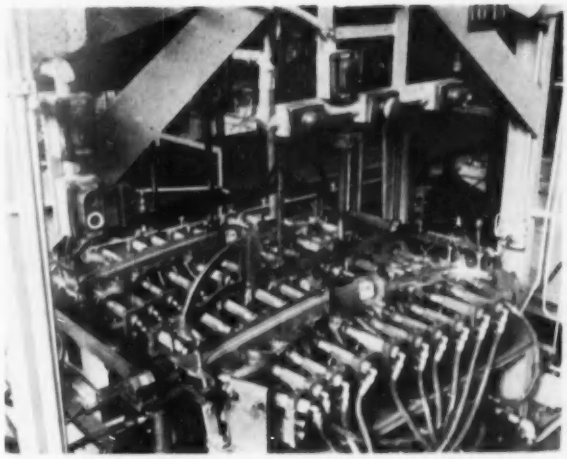
increasing his skill or by learning new trades and new techniques for the automated plants that are blossoming throughout the United States. Young men going into industry now have a greater opportunity than ever before to find employment in the skilled trades. Automation requires more electricians, more millwrights, more toolmakers, more diemakers, and more machine repairmen.

There are still some manufacturers who consider automation valuable only to the extent that productive labor can be reduced through the use of automated machinery. No policy could be more shortsighted. The approach to automation strictly from the standpoint of reduction in productive labor is false economy. It simply will not pay off in the long run.

There is no doubt that on some operations manpower can be saved through the use of automated equipment. The overall effect of automation, however, probably will be to increase total employment.

With the increasing use of automation will come an increase in the number of maintenance personnel and technical specialists who will concern themselves with the never-ending task of improving and refining mechanical processes.

Forward looking companies do not wait for these skills to be developed in sufficient quantities from outside sources. They help their workers through special schools and courses to acquire the skills that the new automated factories of the future will require.



FUTURE WILL BRING AUTOMATED ASSEMBLY, which is much more complicated than current automated manufacturing. Beginning has been made in welding. This multiple transformer welder simultaneously welds two body center-pillar assemblies. Pillar at front station receives 24 welds. Then it moves to rear station and gets 24 more welds

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

In-Plant Communication . . .

. . . to be effective must be a two-way proposition operating in a favorable climate. Management needs to cultivate the forgotten art of listening.

Based on panel secretary's report by **Ken Arnold,** Cannon Electric Co.

THE problem of communications is not new. What is new is the widespread recognition of its importance. Today it is spelled with a capital "C" which leads too often to paying more attention to the label than the process.

Communications is a problem at all levels—executive and general management and hourly employee. And the process of communication works, or should work, both up and down through an organization as well as out to the community at large.

There must be a proper climate for good executive management communication. There must be also an effective vehicle to carry it. In small companies face-to-face contact on a day-to-day basis works best, but the larger the organization the greater the chance of misunderstanding because such contacts are rare. Here the written word serves best.

Some companies use opinion surveys to determine what the employee really thinks and use this to guide communications. Surveys provide a contact and implement a true "open door" policy. Not only does the employee come to know what goes on and become familiar with company policy, he also can talk back. It is highly important that management know and not guess how the employee feels, and that the employee has a chance to express that feeling freely.

Physical situations and mental attitudes may constitute barriers to communications. Lack of definite policy, an authoritarian climate, timidity, and poor past records are among management failings. So, too, are jealousy, fear, and prejudice. These can be overcome if management is sincere in wanting to do so.

One of the best ways to test effectiveness of communications is the employee feed-back. You get this through listening. But listening has become a lost art. Management doesn't listen because it prejudges, makes up its mind too quickly, or is preoccupied with other matters. "Listeners" have many bad habits—their minds hop around, the eagerness of getting facts precludes getting the meaning, there is a preoccupation with note taking or a preference for doing the talking. These are some of the habits

that need correction. Real communication comes about only when we are able to listen with understanding to see another's point of view objectively.

Communications extend beyond the confines of a plant to influence the enterprise system. This is inevitable. In-plant communications break out into a community through people and in the larger sense what breaks through, whether it be good or bad, is but the reflection of what a company is.

(This article is based on papers presented by a panel on "Effective In-Plant Communication" held as part of the Aircraft Production Forum, National Aeronautic Meeting, Los Angeles, Oct. 5, 1954. Secretary of the Panel was Ken Arnold, Cannon Electric Co. Panel members were: G. Bradley, AiResearch Mfg. Co., J. Curtis Counts, Douglas Aircraft Co., C. A. McKeand, Merchants & Manufacturers Association, Lee Stockford, Lockheed Aircraft Corp., W. H. Thaw, TransWorld Airlines, Inc. and R. Van Nostrand, Merchants & Manufacturers Association.

The report on this panel is available in full in multilith form together with reports of the nine other panel sessions of the 1954 Aircraft Production Forum. This publication, SP-309, is available from the SAE Special Publications Department. Price: $2.00 to members; $4.00 to nonmembers.)

Radioisotopes . . .

. . . have already saved industry some $100,000,000 in process control. Some of the saving is going to the automotive industry.

Based on paper by **A. Tammaro,** U. S. Atomic Energy Commission

OVER 1100 industrial companies are now using radioactive materials to help solve some of their production and process control problems, among them several companies in the automotive industry.

Ford has been one of the leaders in use of radiographic (non-destructive) testing with artificially produced radioisotopes such as cobalt-60, selenium-75 and iridium-192. Excellent photographs have been obtained showing the efficiency of this method for detecting small voids in castings and imperfections in welds and castings. More than 350 other companies are using this method with profit.

It took an oil company to devise a method for measuring the wear of piston rings in an automobile engine. The Atlantic Refining Co. used isotopes in 1938, prepared by cyclotron bombardment. The California Research Co. attacked the problem in 1948 by sending piston rings to Oak Ridge for insertion in our nuclear reactor. These rings became radioactive, they were assembled in an engine, oil was poured in the crankcase, and the engine was started. The amount of material worn off the piston ring was determined by measuring the radioactivity of the oil containing the abraded iron. The time required for measurements was reduced from months to minutes, or as the company puts it, from $1,000,000 and 60 man-years to a research budget of $35,000 and 4 man-years.

Massachusetts Institute of Technology has been using radioactive materials for some eight years for basic studies in friction phenomena. M.I.T. has proved that friction between two sliding pieces of metal actually involves a shearing of the two metals, and that they are deposited one upon the other in microscopic "bumps" rather than in thin sheets or streaks. Autoradiography permits quantitative measurement of the amount of material transferred, detecting as little as 1/500,000 ounce per minute of wear. The wear of pinion and sun gears has been investigated, particulary under conditions of high pressures and torques.

The Chrysler Corp. established a radioisotope laboratory a few years ago out of which has come a new method for measuring breakerpoint wear. One part is made radioactive by bombardment with neutrons. The non-radioactive one is then measured, after operation of the assembly, to see how much radioactivity has been picked up. The increase in sensitivity over conventional measure is several hundredfold.

Thickness gages have been applied to the production of tires by several companies. B. F. Goodrich has incorporated phosphorus-32 into the tread of tires and has been able to measure the amount of tire wear occasioned by only a few feet of travel under normal conditions.

Radioisotope thickness gages have been used to measure sheet material such as brass, steel, aluminum, plastics, and the like. The gage permits measurement without stopping the production line. Surprising savings can accrue from lowering the excess of a sheet by only a few millionths of an inch, particularly where the finished material is sold in thousands of tons annually. Over 400 companies are using radioisotope gages.

General Electric has recently completed a project which involves measuring the wear of the commutator in an electric motor. And General Motors has just established a radioisotope research laboratory.

The automotive industry has only scratched the field of industrial application of radioactive materials. There's much more waiting to be done. (Paper "The Potential Contribution of the Automotive Industry to the Field of Atomic Energy" was presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 11, 1955. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

How Ford Installs An Automation System

G. G. Murie, Ford Motor Co.

Based on paper, "Automation and Its Requirements," presented at the SAE Golden Anniversary Annual Meeting, Detroit, Jan. 11, 1955.

AT Ford, the development of an automation system for handling an automotive part between manufacturing operations proceeds as follows:

1. Management assigns one automation engineer to be in charge of the project.

2. Preliminary studies determine the adaptability of the part to automation and the extent to which automation is economically justified.

3. A preliminary automation layout is made. From it installed cost and manpower requirements are estimated.

4. As soon as the program is approved, the automation engineer must start to coordinate all phases of design in the actual setting up of the automation system.

5. As long as the system is operating, an extensive preventive maintenance program is needed.

This rather involved process is made necessary, in part, by the need to consider such danger spots as:

1. Specialized nature of the equipment and the great variety of designs of the load and unload stations of the machines in the layout.

2. Timing of installation. (It is best to install automation devices during model changes, when rearrangements are often necessary anyway, because of changes in processing.)

3. Coordinating so many elements, such as plant layout, tool and die design, material handling, and the machine tool builders.

4. Maintenance. (Use of automation causes maintenance problems, which could offset the savings to be made, if not properly handled.)

One Automation Engineer in Charge

Ordinarily, one automation engineer is given responsibility for the work on a complete automotive part. He stays with the job all the way through, until the entire automation system is in operation. He will even keep in close touch with field conditions to take care of minor changes that may be necessary as the various items of production equipment are installed in their proper places.

Obviously, such an engineer must not only be a specialist on automation design. He must have imagination and engineering knowledge. He must be able to lead and coordinate the program.

This type of man starts analyzing a program in the first step, as soon as the general plant layout has been agreed upon and when detailed layouts are still in their early stages.

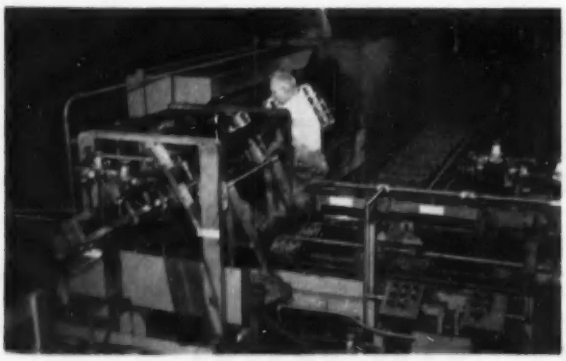
When the detailed plant layout is being developed, the automation engineer must be readily available for consultation. Only in this way can the installation of the simplest possible transfer mechanism be assured. About this time, production and higher management groups may view the overall plan.

Preliminary Studies

Quick calculations and simple sketches make up the preliminary studies. It is often found that the right type of automation equipment costs very little more than standard equipment that could be considered a minimum requirement.

In general, the extent of automation at Ford today has largely been determined by engineering studies, company experiences and the experience of the machine tool industry as a whole. These, coupled with an economic analysis, indicated how far it was practical to go with automatic handling.

In the light of this background, the part to be pro-



Automation applied to loading and unloading of machine to clean overhead-valve cylinder heads for Ford V-8 engines

duced is carefully studied for adaptability to automation. Preliminary manpower estimates must be considered. We may find that one operator can load and unload several or more machines. He may be required for reasons other than loading, such as assembly, manual control, or observation. In this case automation may not be advisable.

The early automation programs were chiefly concerned with the rearrangement of standard and existing machines, to tie them together with mechanical devices—the start of the transfer machine.

Present-day programs are based on the wide introduction of machinery and equipment that have been designed with automation in mind.

Preliminary Automation Layout

Once the plant layout is settled, the automation engineer must detail the complete program. An overall layout is made, showing all the elements.

Installed cost is estimated from this layout. Manpower requirements are also determined by comparing the new layout with the standard layout using minimum equipment. From this analysis one can decide how much automation may be required. A summary of these data are then presented to management for approval.

A true picture of the estimated cost savings and all financial factors will prevent the expenditure of funds on schemes that may be spectacular but with very little benefit. This phase is especially significant in the automotive industry, where many parts become obsolete after one model year.

Obviously, for such parts, systems that do not amortize themselves in less than a model year may not be economically advisable. On the other hand, in the press lines for body parts and machining lines for engine and chassis parts, longer amortization periods may be permissible. Very often, on some of these parts the basic system can be utilized for several years, inasmuch as the year-to-year changes would not make the equipment obsolete.

As an example of how an automation study improved an entire operation, let us consider the cylinder blocks being manufactured in highly automated equipment at the Cleveland engine plant. The machinery and equipment are all new and of the latest design, with many new transfer machines.

Roller conveyors were used throughout the original engine plant layouts. Several machine lines were required to give sufficient production. As the operations progressed, they were split up from one machine per operation to two or three machines per operation, and then later these were broken down even further. This required a complex system of roller conveyors, with much manual handling, since the blocks frequently had to be turned over or rotated 90 deg.

An analysis by the automation section indicated the need for automation equipment. The resulting plant layout was much more compact and the system of automation developed was an extension of much of the work that had been done by the machine tool builders in designing the machine. Parts handling was substantially decreased. The entire department became a synchronized system, functioning as one large transfer machine. It was not necessary for the operator to push, pull, turn over, or position a part.

Thus, although higher in cost, the new system was worthwhile because of its many advantages.

Considerably less direct labor was needed, but more indirect labor was needed to service equipment.

In effect, the manpower was required to watch for defects appearing in the operating mechanism before they became major breakdowns.

Coordination

In coordinating all phases of the design, the automation engineer must see that the preliminary plant layouts are revised, wherever necessary, so that the automation equipment is allowed adequate space. He must advise the processing department to revise their operation sheets, where necessary, to include the automation equipment. He must also consult the machine tool designer, so that the working height, position, clearance, and the like, of the loading and unloading stations are properly adjusted for automation.

Preventive Maintenance

In the past, maintenance was based on repairing equipment after it had broken down. This approach is not satisfactory today. The entire production system at Ford is geared to a uniform production rate per hour, without an allowance for making up lost production caused by breakdowns. Thus, the breakdown of just one small element could shut down the entire production line.

Preventive maintenance is the key to continuing production. It involves generally the keeping of accurate records of lubrication, expectant life of perishable parts, and the replacing of these parts before they fail and stop production.

An important phase of this program is to select men to run the automation departments who can keep them in first-class condition and recognize when troubles are threatening.

Thus, it is clear that production people will have to be more highly trained, on the average, than in the past. To develop the type of worker required, factory management of the future must be prepared to assist in a training program to develop the skills needed.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

See lower parts rejection rates from

New SAE Dimensioning Standards

Revised geometric and positional tolerancing specifications permit greater parts interchangeability

Col. C. M. Buhl, Budd Co.
Dean Jasper Gerardi, University of Detroit
G. L. McCain, Chrysler Corp.

This report was prepared by the above members of the SAE Joint Drafting Standards Committee to emphasize the significance of the new SAE Standards on dimensioning.

EXPANSION of industry, our Department of Defense, and the correlation of engineering work in the mechanical industries have focused critical attention on the necessity of standardizing the dimensioning of detail drawings.

Three new sections of the SAE Automotive Drafting Standards, which have recently been published, explain principles and methods for specifying geometric and positional tolerancing. They include fundamental principles of dimensioning, application of size tolerances, decimal dimensioning, choice of datum, and methods of specifying permissible limits of flatness, straightness, angularity, symmetry, concentricity, and combinations of these variations. Methods of dimensioning common features are illustrated so that the standard may be used directly by all draftsmen and engineers. In order to illustrate some of these principles, a few examples are discussed in the following article with an introduction to the recommendations included in the new standard.

Geometric Tolerancing

Geometric Tolerancing includes the control of form, such as roundness, squareness, flatness, and symmetry. The term "geometric" implies in one case the control of roundness and concentricity and combinations of these characteristics. A perfectly cylindrical shaft might fit into a perfectly cylindrical hole of the same size, but since neither one can be produced, we always allow some clearance. If both shaft and hole are elliptical, they might go together in one place; but if there must be relative motion between them, the largest dimension of the shaft must be less than the smallest dimension of the hole or bearing. If a cylinder, representing the largest permissible shaft, will go inside a cylindrical hole, representing the smallest permissible size, each of these cylindrical shapes may be used as limits for tolerance zones. Fig. 1 shows a shaft with its tolerance zone.

Within this tolerance zone, there may occur out-of-roundness, out-of-straightness (if the shaft has appreciable length), and a sort of waviness which might be defined as an out-of-roundness. However, none of these variations may be permitted when the shaft is at maximum diameter, as any variation would cause the surface to exceed the limits of the tolerance zone. If the shaft is everywhere at minimum diameter, it cannot vary from a true cylindrical form; hence all variations must be between the high and low limits of the features as shown in Fig. 1. It can be said that at maximum diameter (maxi-

How It Happened

IN 1953 **W. A. SILER**, Chairman of the SAE Automotive Drafting Committee, announced to his committee that the British Standards Institution had published British Standard 308 on Engineering Drawing Practice. Siler complimented the Institution for producing a document from which drawings could be made more readily understood in the U. S. A., Britain, and Canada. He asked the Committee to make a thorough study of this standard and proposed that members of both the aeronautical and automotive committees study their respective standards. Siler reviewed the results of conferences which had been held in Ottawa, Canada and New York and stated that every effort should be made to unify our drafting practices, not only on a national level, but also on an international level.

The first step, however, was to reconcile differences of opinion between aeronautical and automotive groups and prepare a standard which would reflect the best SAE drawing practices. O. E. Kirchner, Chairman of the SAE Aeronautical Drafting Committee, concurred with Siler, and early in 1953 a joint committee was authorized to prepare a proposal. Work was completed in December, 1954 and approved by the SAE Technical Board at its annual meeting in Detroit in January, 1955.

mum material) there cannot be any tolerance of form, but that away from maximum diameter, errors of form may be permissible until they reach minimum diameter.

This same principle also applies to the internal cylindrical form, because at its minimum diameter it is in the maximum material condition.

Therefore, **a feature at its maximum material condition as defined by its dimensions, may not vary in form. And the geometrical tolerance may be referred to as zero. However, when the feature is away from maximum material condition of size, then geometric variations may be permitted within the zone defined by maximum and minimum limits of size.**

Positional Tolerance With Directly Toleranced Features

A simple example of positional tolerancing of a feature is shown in A of Fig. 2. The position tolerance allows the center distance to become maximum, as at B, or minimum, as at C. Since both conditions are acceptable, the inspection gage must be made as at D, so that the pins in the gage set on 2.00 in. center distance will just contact the inside edges of the feature with maximum center distance and the outside edges of the feature at minimm center distance. The sketch at D shows the diameter of gage pins which will accept a part whose holes are at minimum diameter and center distances are at maximum and minimum. If the holes are both at maximum diameter, then the same gage, as at E, would accept the part even though the center distance was greater, or less, than the limits specified on the drawing as shown at E.

It is not uncommon practice to make inspection gages in this manner, and the gage is usually the means of inspecting the part. It may be expected that all parts which are accepted by the gage are then usable.

If there is no restriction on the drawing, and if parts will function as required, this extra available tolerance, which in the above case amounts to one-half the hole size tolerance, may be used to advantage, fewer parts would be scrapped, cost reduced, efficiency and interchangeability increased.

Tolerances are usually selected to apply at maximum material condition, but may be increased when the part is away from maximum material condition, unless restrictions are noted on the drawing. If the center distance must be held to the tolerance specified, it should not be subject to an extra tolerance because of hole size variation. In such cases the

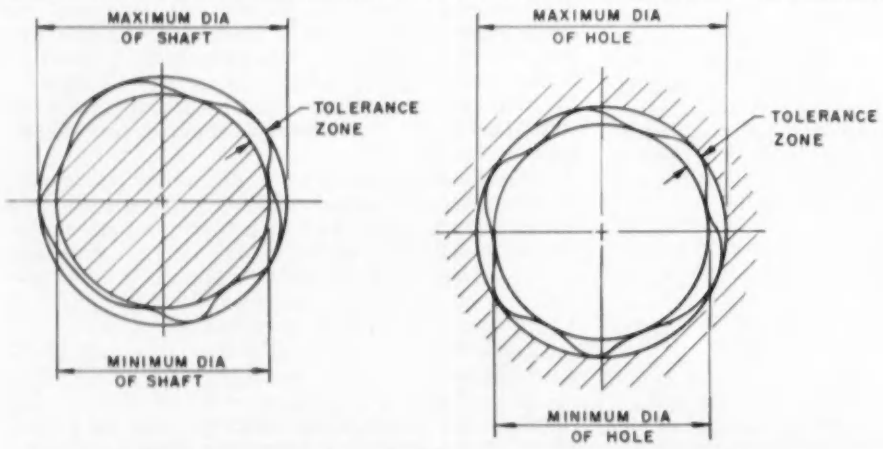


Fig. 1—Within the tolerance zones of a shaft (left) and a hole (right) there may occur "out-of-roundness" and "out-of-straightness." At maximum material, that is maximum diameter for the shaft and minimum diameter for the hole, there cannot be any tolerance of form

drawing may state "regardless of feature size," and when this restriction is necessary, an appropriate type of gage must be used.

The two conditions just described illustrate the two important interpretations of positional tolerancing, termed the "liberal" and the "restricted" applications. Since the restricted application is used only where required, particular care should be exercised to make the requirements clear on the drawing by wording the tolerance notes so as to avoid any possible misunderstanding. See Fig. 3. This conveys the information that position must be controlled independently of any other variation by tools and gages made to enforce the restricted limits. The two upper holes must be held on centers whose maximum distance is 1.804 in. and minimum distance is 1.796 in., while the lower holes may exceed these limits and could vary from 1.810 to 1.790 in.

True position tolerancing is just as simple as any method of dimensioning can be made, for the permissible variation is in all cases included in the circle which defines the tolerance zone as shown in Fig. 3. On the other hand, direct tolerances, as shown in Fig. 4, allow variation in the direction indicated by the dimension lines, which would result in square tolerance zones whose corners are farther away from the desired position than in the case of the true positioning method with the circular tolerance zone.

When variation may occur anywhere within the square shown in Fig. 5, a maximum in excess of the intended tolerance may occur at 45 deg from horizontal or vertical direction in which the tolerances have been indicated; hence, more accuracy may be expected where a circular tolerance zone is used in place of a square one.

When tolerances are applied to coordinate di-

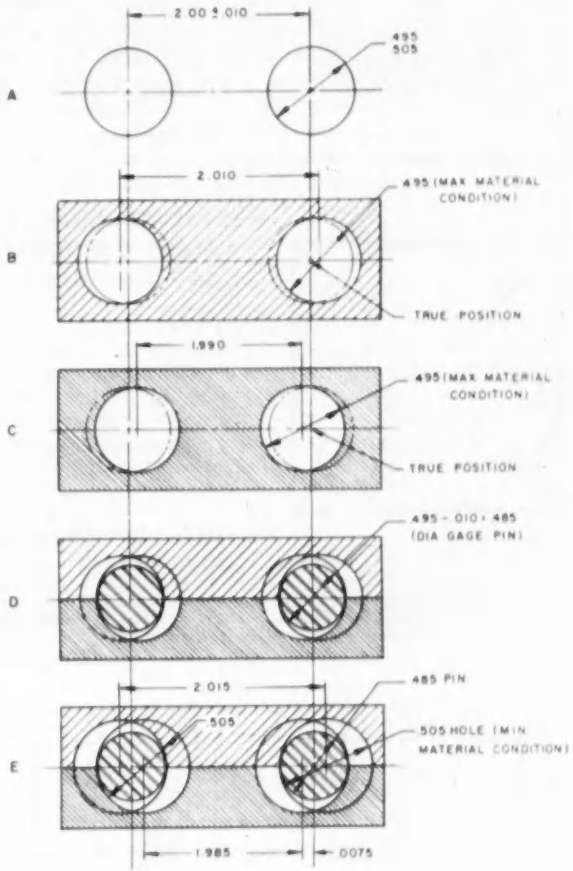


Fig. 2—An example of positional tolerancing

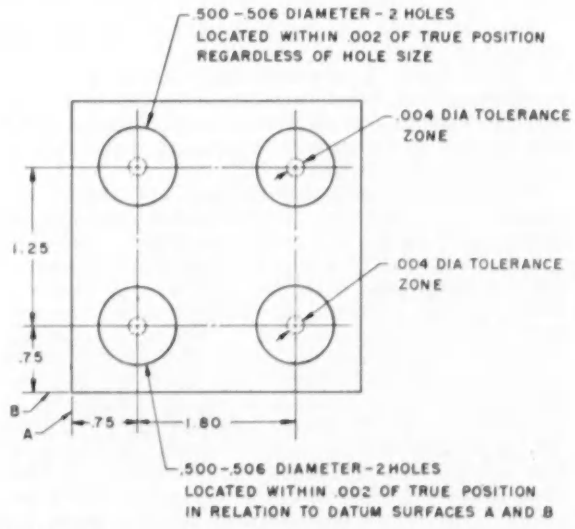


Fig. 3—The two upper holes must be held on centers whose maximum distance is 1.804 in. and minimum distance is 1.796 in.; while the lower holes may exceed these limits and could vary from 1.810 to 1.790 in.

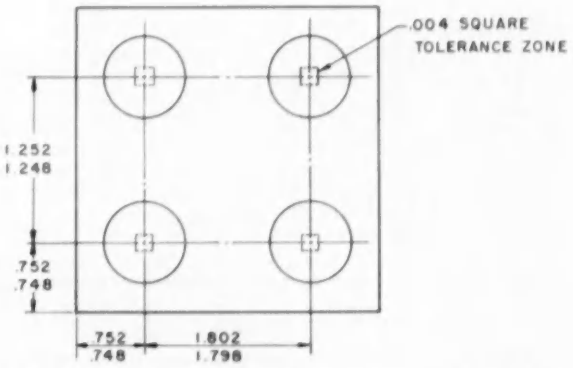


Fig. 4—Direct tolerances allow variation in the direction indicated by the dimension lines resulting in square tolerance zones whose corners are farther away from the desired position than with the true position method with circular tolerance zone

mensions and are not uniform, the tolerance pattern will be in the form of rectangles, and where such tolerances are required, true positional tolerances cannot be used. True positional tolerancing can be used only where the required tolerances are uniform in all directions.

We have learned by experience the difference between continuous (or chain) dimensioning and progressive (or step) dimensioning. Fig. 6 illustrates the two methods. It shows the successive type at "A," the progressive at "B," and the true positioning at "C." In the case of "A," the tolerances accumulate with each hole in line. In the case of "B," each hole is controlled from the same base line, preventing tolerance accumulation. In the case of "C" the net result will be the same as that in "B," because the individual tolerances for each hole are the same, regardless of the method of dimensioning.

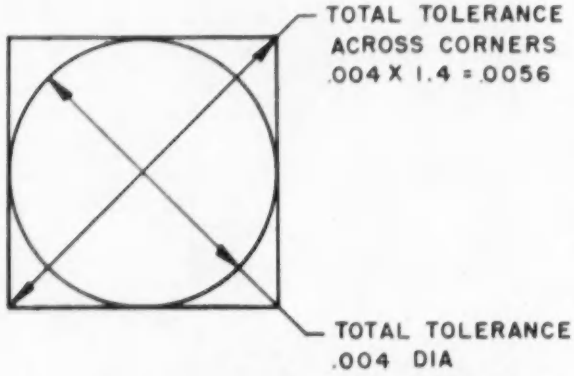


Fig. 5—A maximum variation in excess of the intended tolerance may occur at 45 deg from horizontal or vertical direction in which the tolerances have been indicated

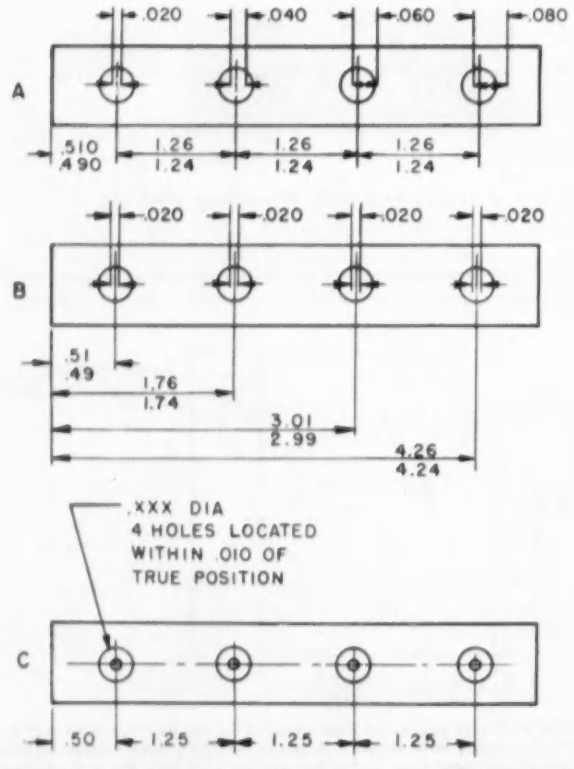


Fig. 6—Types of dimensioning: (A) successive, (B) progressive (C) true positioning

Why New Standards Were Set Up

Two of America's industries, the automotive and the aeronautical, representing 20 billion dollars of our national productive income, depend on mass production to supply markets all over the world with air and ground vehicles of all kinds. Although these industries are highly competitive, they have a common general objective—high production, and excellence in performance of the product at least cost.

The complexity of modern mass production, on both national and international levels, has increased demand for interchangeability and for more efficient performance and durability. Also, during periods of high stress, it has been found difficult for a manufacturer to make parts from another manufacturer's drawing.

To avoid unnecessary cost, complete information must be included on drawings, concisely expressed in terms which are understood by all concerned. The emphasis for cutting costs has shifted from the shop to the engineering and design office. Add to this the fact that the scientific development of most equipment today calls for a high degree of precision in a large number of parts, and we find that cost must be reduced if the product is to survive in a competitive market.

Precision parts having toleranced features are expensive. Costs can be reduced if an attempt is made to create better understanding between the design engineer, whose primary object is to create, and the gage or tool engineer, whose responsibility it is to meet the proper functional requirements as set forth by the designer.

Each of these personalities has a different approach to a project. The designer creates, he builds—both in his mind and on paper. The very nature of his work causes his mental processes to become essentially inductive. While it is not implied that he is casual or careless about the importance of tolerances in the proper functioning of parts, it is true that the design of the components usually constitute his primary interest and responsibility. A designer or engineer is likely to be more aware of such factors as chemical and physical properties of materials, stresses, performance, fabrication, costs, and servicing. He recognizes that appropriate tolerancing is a factor in all these elements, but often assumes that the gage engineers will cooperate to assure proper functioning of the product he designs.

The gage engineer is a deductive-minded fellow. Experience has taught him that in many cases the tolerances shown on a drawing do not necessarily

mean what they say and he may assume that the design engineer depends on his services to assure the intended or required degree of functional quality. A competent gage engineer first analyzes the new drawing to visualize proper functioning of the part, the quality of work required, and economy in materials and fabrication. This analysis by the gage specialist is extremely important. As a corollary to this analysis he determines whether accumulations of size, positional, or form tolerances are consonant with functional requirements of the part or combination of parts.

Rejection and scrapping of parts which are not in accordance with drawing requirements have always been problems. The inspector has gages which are made to accept or reject a part on the basis of its dimensions or functions. Other inspectors may reject the part because of structural defects or surface imperfections. Sometimes, a chief inspector may override the part inspector and decide that in spite of such imperfections the part is usable. This he may do because he knows the functioning requirements of the part and applies a liberal interpretation to the tolerances as stated on the drawing. For reasons of economy, reduction of scrap loss, and facility of manufacture, the gage is normally designed to accept the broadest or coarsest tolerances which permit ready interchangeability and proper functioning.

Let it again be emphasized that the designer is not considered to be oblivious of limits to which work must be held to assure proper functioning of the part. He could be the most tolerance conscious person imaginable—but under the present dimensioning systems may lack the means whereby he can indicate whether or not an accumulation of size and positional tolerances is permissible. This leaves the interpretation of tolerances open to both the gage engineer and the tool engineer—and unfortunately their respective interpretations, too often, remain uncoordinated.

In order to eliminate these shortcomings, and to reduce costs which result from misinterpretation in our present drawing practices, the Society of Automotive Engineers revised the portion of the Drafting Standard which deals with tolerances.

The new SAE Standard for dimensioning now appears in the SAE Automotive Drafting Standards, copies of which can be obtained from SAE Special Publications Department. Price: $5.00 to members and to nonmembers. The dimensioning standard is also published as a supplement to the SAE Aeronautic Drafting Manual.

Mollerizing . . .

. . . a new method of coating steel with aluminum is competitive with galvanizing and lends itself to batch or continuous processing. It's applicable also to titanium and molybdenum.

Based on papers by **H. E. Linden,** American Mollerizing Corp. and **E. Walden,** Lockheed Aircraft Corp.

THE coating of steel with aluminum by the process called mollerizing after its inventor, G. A. Moller, begins with a thorough cleaning and pickling of the material to be coated so that it enters the mollerizing furnace with a metallurgically clean surface. After attaining the same temperature as the salt in the electric salt bath furnace, the steel to be coated is withdrawn through the molten aluminum and washed in hot water to remove any trace of salt.

Since the thickness of the molten aluminum is only about 2 in., a withdrawal through that layer at the rate of 150 fpm produces a contact with the aluminum lasting only one-third of a second. Thickness of the coating is determined largely by the rate of withdrawal and the temperature. Furnace temperatures range from 1300 to 1600 F. No flux is used prior to immersion.

If the mollerized material is to be heat-treated, it can be done by taking the material as it comes from the furnace and putting it in oil or water for quenching and then stress-relieving it at a lower temperature. Under these conditions the mollerized material does not have to be cleaned nor will any surface cracks appear.

Mollerizing has been applied to both titanium and molybdenum successfully. Experience has shown that whereas titanium seemed ideally suited to replace stainless steel, its tensile strength dropped rapidly above 1000 F, while its great affinity for oxygen and nitrogen caused it to be badly embrittled by prolonged heating above 1200 F. Preliminary tests indicate that an aluminum coating on pure titanium provides partial protection against embrittlement at elevated temperatures. The coating is also effective in reducing the tendency of titanium to gall and seize on the die during deep drawing operations.

Small molybdenum panels have been coated. Results are most encouraging. Here again, the coating protects against high temperatures. (Papers "Mollerizing—A New Method of Coating Steel with Aluminum to Protect It Against Corrosion and High Temperatures" (Linden) and "Mollerizing Titanium" (Walden) were presented at SAE Southern California Section, Jan. 28, 1954.)

Production-Design Teamwork

IN developing a new engine one important consideration is how the design will affect foundry methods. Conversely, new casting concepts and techniques should be taken into account during the first formative stages of engine design. Chevrolet and Pontiac have shown, in their 1955 engines, that the result of such integration is simplified castings, easier machining procedures, and reduced costs.

At Chevrolet . . .

At the Chevrolet foundry, cylinder blocks are cast differently from traditional methods. A block that has many cores naturally has the problem of variations on every core, and the stack-up of those variations during assembly of the cores. Chevrolet uses fewer cores. Thus, section thickness can be controlled much more accurately, and there is less sand to handle. The end result is a precision casting which is lighter, as well as lower in cost.

The cylinder barrel cores are formed in pairs. That is, one left-hand and one right-hand barrel are integral with a crank chamber core in the form of a V. Fig. 1 is a photograph of a pair of cores.

There are four of these basic cylinder barrel and crank chamber cores, which are set on a slab in the drag, as shown in Fig. 2.

Two one-piece jacket cores are then slipped over the cylinder barrel V cores (Fig. 3). The jacket cores are supported in position and restrained from flotation by the end cores of the block. These end

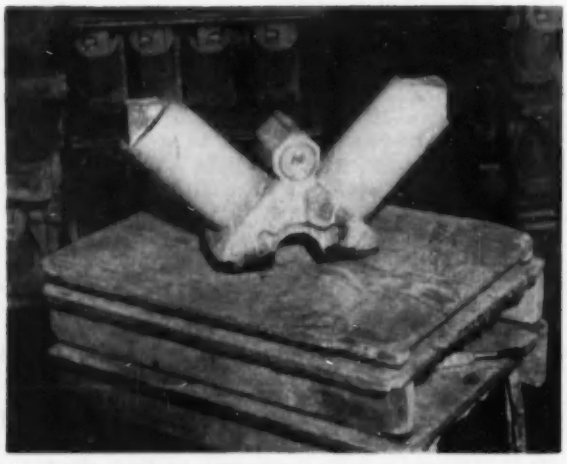


Fig. 1—Cylinder barrel cores are formed in pairs integral with a crank chamber core in the form of a V

Fig. 2—These four basic cylinder barrel and crank chamber cores are set on a slab in the drag

in the Foundry

C. B. Leach and E. L. Windeler
Pontiac Motor Division, General Motors Corp.

R. F. Sanders
Chevrolet Motor Division, General Motors Corp.

Based on papers "The New Pontiac V-8 Engine" and "The New Chevrolet V-8 Engine" presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 12, 1955. Both of these papers will be published in full in 1955 SAE Transactions.

cores, also supported and located on the slab, form the contours of the timing chain case and frontal architecture, and the configurations of the clutch housing attachment. Large core prints project from these end cores to support the jacket cores, as illustrated in Fig. 4.

The entire assembly of cores is pasted and gaged on the slab core in a core drying fixture. After drying, it is conveyed to the molding floor, where, after blowing out loose core sand, the entire assembly is lowered into the drag mold in one operation (Fig. 5). Since the simple assembly operation eliminates individual core handling on a moving conveyor and the resultant loose sand in the mold, this process produces a clean, precision casting.

Only nine major and three minor cores are used in the casting of the Chevrolet block. By comparison, another manufacturer uses 22 cores in the casting of a V-8 block. Also, Chevrolet uses only 131 lb of sand to make cylinder block cores, while the other V-8 requires 222 lb.

In casting the cylinder head, the main objectives were precision, combined with low heat rejection to the coolant, and low weight. The heads are interchangeable, and have the water outlets on the inner face at each end. This eliminates any machine

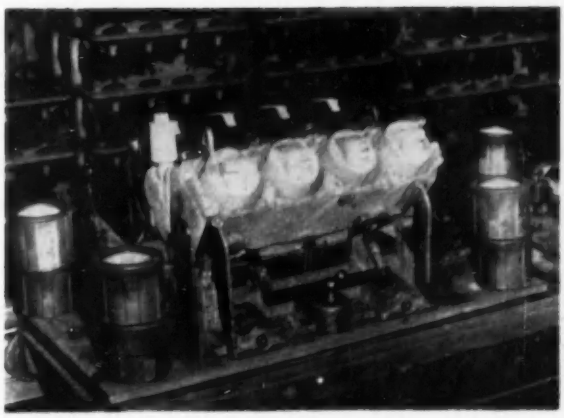


Fig. 3—Two one-piece jacket cores are slipped over the cylinder barrel V cores

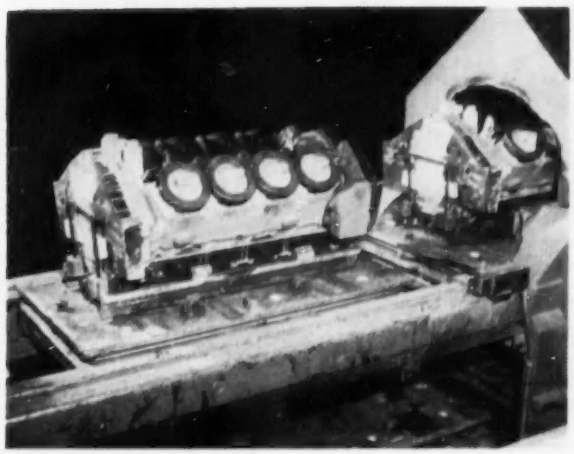


Fig. 4—Large core prints project from the end cores to support the jacket cores

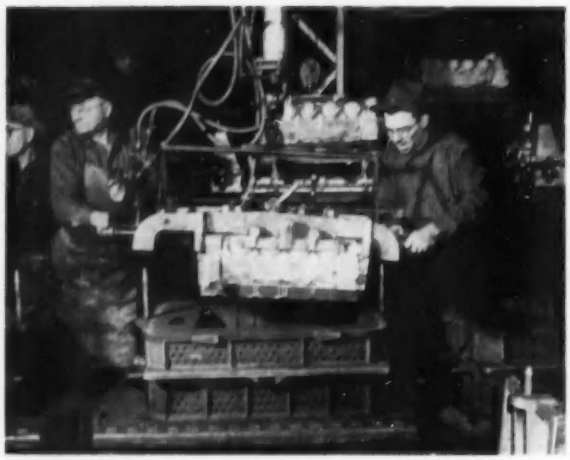


Fig. 5—The entire core assembly is lowered into the drag mold in one operation

operation or core prints on the front and rear faces of the head.

The cylinder head slab core includes the contours of the four combustion chambers, as shown in Fig. 6A. The successive steps of assembling are shown in Figs. 6A, 6B, 6C, and 6D. During assembly the cores are pasted together at prints and joint surfaces, after which the complete assembly is dried in an oven.

Upside down casting method

The drag pattern contains the outside contour of the head in the green sand. The dried core assembly is inverted and placed in the drag mold. The slab then acts as a cover core, and is held down by the cope, which contains only the impression for sprue runners and risers. This "upside down" method of casting results in harder iron at the bottom of the head and around the valve seats, which is desirable.

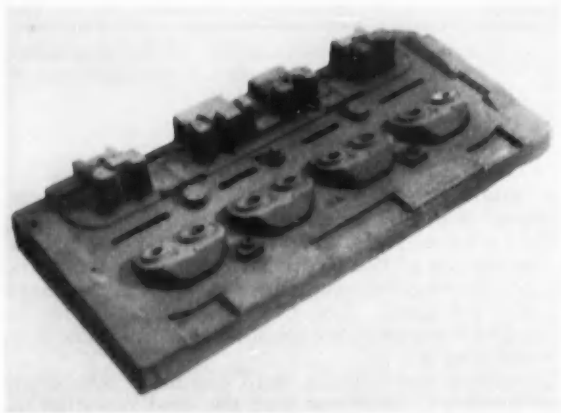
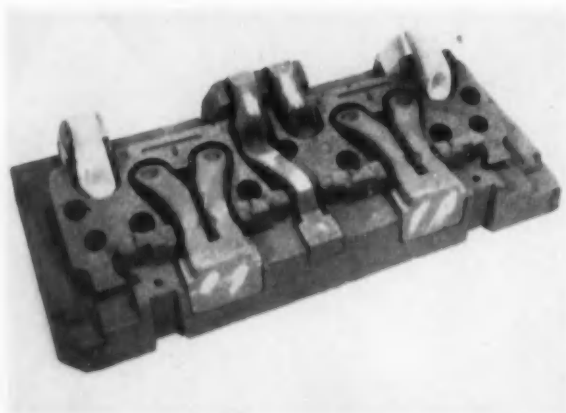
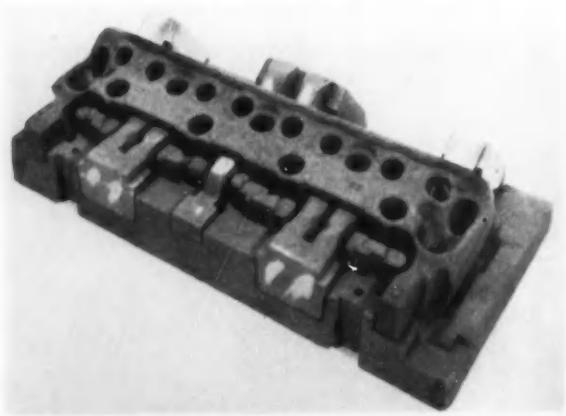


Fig. 6A—The cylinder head slab core includes the contours of the four combustion chambers

6B—The lower water jacket core is set on the slab



6C—Next, the gas passage cores are added



6D—The upper water jacket core follows

Combustion chamber shape

The wedge-type combustion chamber is cast to shape, and not machined. This allows the volume to be placed just where desired, since there is no limitation by a cutter diameter. The only machining necessary in the chamber is for the valves. Even this operation is greatly facilitated because the valves are all in line.

At Pontiac . . .

In designing its 1955 engine, Pontiac also simplified casting procedures. The total number of cores required to cast one cylinder block and two cylinder heads was reduced from 34 to 16. The total weight of the dry sand cores was reduced from 320 to 158 lb. This reduction in cores was made possible by careful integration of a new casting concept into the design of the engine.

As shown in the transverse cross-section through the cylinder block mold, Fig. 7, there are no flanges which project into the center area at the top of the cylinder block. This makes it possible to use green sand to form the entire top surface. Also significant is the fact that the barrel cores, which form the cylinders, are an integral part of the crankcase cores.

The longitudinal section through the mold, Fig. 8, shows more details of the casting method. The dry sand core at the rear of the block is the only core required to form an external surface. Separate core assemblies requiring pasting and nailing have been virtually eliminated, and the cores are fixture set directly into the mold. This casting simplification reduced the probability of core shift during pouring, and has made possible the lowest-weight castings consistent with quality production.

Another achievement in casting simplification was made on the cylinder heads. Eight cores were required to cast an early experimental cylinder head in the conventional manner. Only four cores, shown in Fig. 9, were required for the production cylinder head.

A salient feature is the absence of separate core assemblies requiring the pasting together of water jacket cores. Such pasting may result in the unpredictable occurrence of fins in the water jackets, where they can disturb the flow of coolant and upset temperature balance. In this casting method, all cores are set directly into the mold. Such fins as are necessary are so placed as not to affect the flow of coolant in the critical area between the valves and at the valve guides.

Core sections were in all cases kept large enough to assure clean, uniform water jackets free from burned-in iron. (Papers on which this abridgment is based are available in full in multilithographed form from SAE Special Publications Department. Price (each): 35¢ to members, 60¢ to nonmembers.)

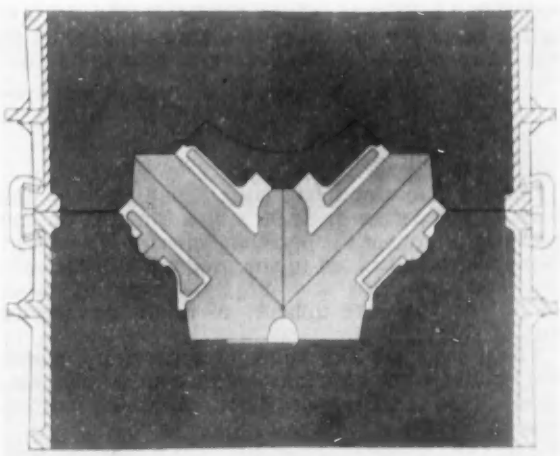


Fig. 7—This transverse section of the Pontiac cylinder block shows that the barrel cores are in integral part of the crankcase cores, similar to the Chevrolet

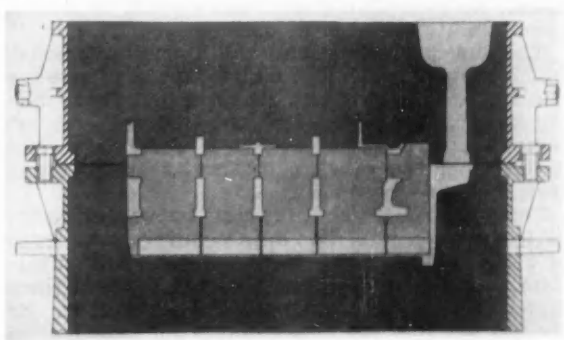


Fig. 8—This longitudinal section through the mold shows that cores are fixture set directly into the mold

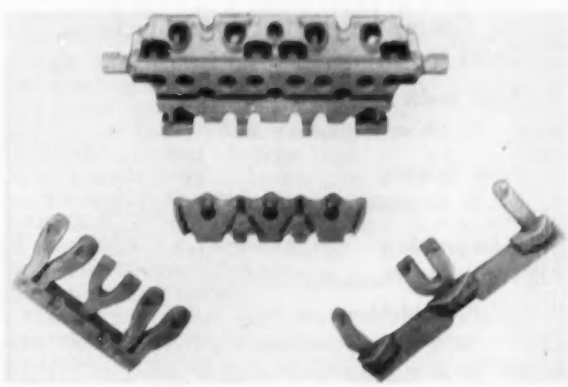


Fig. 9—Only four cores are now required for the engine cylinder head, in contrast to eight when using conventional casting methods

Keeping Control of Indirect Manufacturing

CONTROLLING and reducing indirect manufacturing costs are necessary if a manufacturer is to stay competitive. There are several ways to do this:

(1) Using flexible budgeting as a tool of management
(2) Controlling engineering costs
(3) Controlling indirect labor costs

Indirect manufacturing costs usually do not appear on the design engineer's blueprints or on the methods engineer's operation sheets. However, they must be allocated to the product. Unlike specific raw materials and clearly designated labor operations they are difficult to relate directly to cost of the product.

These costs are the wages of supervisors, material handlers, machine maintenance mechanics, set-up men, and other service personnel. Other indirect costs, such as cutting tools, abrasives, lubricants, and power, are equally important to the manufacture of a product. Like indirect wages, it is not feasible to control them as a cost of a specific unit of product.

Finding out what your indirect manufacturing costs are will do more than merely show where money has been spent. It will provide data which will bring out weaknesses in operation, and give management the data it needs to reduce costs and increase efficiency.

Indirect costs can be divided into (a) those costs which are inelastic and remain fairly constant regardless of volume, and (b) those costs which fluctuate in relation to volume of goods produced. A flexible budget is an expression in dollars of the sum of a and b. Changes in the character of work, working conditions, or methods will require an adjustment of standard costs.

Members of panel which discussed Keeping Control of Indirect Manufacturing Costs were:

Panel leader

R. Moberly, Marquette University

Panel secretary

O. C. Rheingans, Arthur Anderson & Co.

Panel members

W. G. Thannert, Trackson Co.

P. D. McManus, A. O. Smith Corp.

W. R. Bunge, John Oster Mfg. Co.

F. V. Gardner, F. V. Gardner & Associates

1. Using a Flexible Budget

Each supervisor who authorizes expenditures for supplies and other costs must be responsible for planning these indirect costs and for controlling them. No supervisor should be expected to assume responsibility for costs he does not control.

The supervisor estimates the amount of money which should be spent on indirect costs. These are checked and approved by his superior. Then, during normal operations, the budgeted amounts are compared with actual costs. If there is serious deviation, the operation and budget is analyzed and revised.

Top management controls costs by measuring the performance of each man in successively lower levels of responsibility down to the department supervisor. He, for example, may recommend that three material handlers are needed instead of four. He thereby assumes the responsibility for reducing his material handling costs when volume drops to the three-man level. To reward him for reducing in-

Costs . . . Some specific suggestions by a forum of experts.

O. C. Rheingans, Arthur Anderson & Co.

Based on the secretary's report of Panel on Keeping Control of Indirect Manufacturing Costs held as part of the SAE Production Forum at the SAE National Tractor Meeting, Milwaukee, Sept. 13, 1954.

direct manufacturing costs there should be a foreman's incentive plan.

Flexible budgeting used as an over-all tool of management, becomes a profit plan and has these other advantages:

1. It requires each foreman and supervisor to think ahead and make definite plans for his own operations.

2. It provides a means for co-ordinating the plans of departments within a division and between divisions of a company.

3. It allows planning for varying volumes of production.

4. It can provide a natural line of communication upward as well as downward within the organization. It provides an impersonal means of correcting mistakes and presenting constructive criticism.

5. It makes use of the "management by exception" principle.

6. It trains personnel for greater responsibility by giving them practice in planning.

7. It controls decentralized operations without undue restrictions.

2. Controlling Engineering Costs

Control of engineering costs through budgeting is usually best accomplished by segregating research and development engineering from product and industrial engineering. Research can often be budgeted under development projects, the cost of which may bear no relation to anticipated sales or production volume.

Cost of product engineering (the normal changes in a product rather than development of new products) may be based on annual production or sales volume.

Use of free engineering services offered by vendors of materials and equipment is one way of reducing both development and product engineering costs.

3. Controlling Indirect Labor Costs

Indirect labor costs often exceed costs of direct labor. Up to 50% reduction of indirect labor costs are possible if an adequate incentive system is devised. But it is difficult to establish a standard measure of productivity.

So that indirect labor costs do not get out of hand, many companies use a special timecard rack. Then the supervisor can tell at a glance the number of men doing indirect labor. Some companies use special colored timecards for productive workers doing nonproductive maintenance jobs. They remind the supervisor that he is losing money until the productive worker is given a direct labor job.

Another indirect manufacturing cost which must be controlled is supervision. Sometimes one supervisor can be used for several small departments, thereby cutting costs.

Manpower ratios will tell the effectiveness of supervisors in controlling indirect labor costs. They are directly related to a company's profit planning and the development of manpower requirements. They can substitute for daily dollar-amount budget reports. The following chart may be typical of an

entire company or of a single department:

Hourly Manpower Ratio Objective

Sales		$3,500,000
Desired profit before taxes		350,000
Balance available for costs		$3,150,000
Deduct—		
Sales, administrative, engineering, etc.	$ 124,000	
Direct material costs	1,704,000	
Conversion costs, exclusive of payroll	615,000	2,443,000
Balance available for payroll and fringe benefits		$ 707,000
Breakdown of payroll—		
Fringe benefits	$ 85,000	
Salary	67,000	152,000
Balance available for hourly payroll		$ 555,000
Hourly payroll attendance hours (A) $555,000/$2.50 average hourly rate	222,000	
Standard direct labor hours in shipments (B)	128,000	
Allowed attendance hours per standard hour (A/B)		1.73

The actual manpower ratio is reported to each supervisor daily and can be compared with target ratio so that trends can be seen in each area of supervision.

(The report on which this article is based is available in full in multilith form together with reports of six other panel sessions of the 1954 SAE Production Forum held at the SAE National Tractor Meeting, Milwaukee, September 13, 1954. This publication, SP-308, is available from the SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.)

Aircraft Growth Factor . . .

. . . declared valuable tool in aircraft design and in evaluation of the designs. Helps integrate work of individual groups into the overall design.

Based on paper by **William F. Ballhaus,** Northrop Aircraft, Inc.

THE aircraft growth factor can be used to achieve four goals, namely, to find the right combination of important variables, the correct avenues of design improvement, the gross weight cost of every item of performance and quality, and the minimum weight aircraft to meet any fixed requirements.

Stated as simply as possible, here is what is meant by growth factor: Given a set of reasonable design requirements and specifications, a particular aircraft can be conceived which will exactly meet these requirements. The aircraft will have a certain engine, a certain gross weight, and a certain geometric, structural, and aerodynamic arrangement. If, for any reason, there must be a change in fixed weight, additional gross weight must be added to the aircraft so that it will meet the new requirements. The ratio of the total gross weight change to the fixed weight added is the aircraft growth factor.

To clarify the concept, it should be realized that the gross weight of any aircraft is made up of two types of weight:

1. Fixed weight, which will not change with gross weight, size, strength, quality, or performance.

2. Variable weight, which depends upon gross weight and would vary as we change size, strength, quality, and performance. This is made up of propulsive system weight, fuel weight, and the weight of structure and variable equipment.

It is not necessary to guess the values of important variables such as taper ratio, aspect ratio, thickness ratio, wing loading, power of thrust loading, types of flaps, propeller size, sweep back angle, or fuselage fineness ratio. Proper application of the growth factor analysis will lead to the proper choices of the variables so that the minimum aircraft which exactly meets the requirements will be conceived. The growth factor can be used to show the true cost of increasing the aircraft's capability beyond the stated requirements. The trade can always be expressed as specified gains per pound of total gross weight.

The growth factor is an effective tool in evaluating competing designs. Growth comparisons can be made to indicate the validity of submitted data. They can show the areas of optimism and conservatism clearly, because with them it is possible to place the common denominator of total aircraft gross weight under all items of quality and performance. (Paper "Clear Design Thinking Using the Aircraft Growth Factor" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 8, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on Discussion . . .

John Kuhn, Manson & Kuhn

IT has been found that weight of an aircraft formed a good first approximation, but that for further refinement other parameters, such as energy and number of parts, were more effective. We feel that the weight is such a useful preliminary criterion only because it is so closely linked to the available energy through the weight of the fuel and to the total number of parts.

We have also found it necessary to consider the reliability and producibility of aircraft components at the same time and on the same basis as their performance.

Byproducts of Quality Control Pay Big Dividends

Dale A. Cue, A. O. Smith Corp.

Secretary's report of production panel on, "Bringing Inspection into the Production Team," held during the SAE National Tractor Meeting, Milwaukee, Sept. 13, 1954.

TODAY's quality control departments are fact-finding groups as well as inspectors of product quality. Investigations of quality and cost problems by quality control are furnishing the ammunition for management to make valid decisions. The statistical analysis of these investigations presents a sound scientific basis for taking action. This approach is eliminating biased judgments and incorrect decisions due to lack of knowledge. The analytical applications of statistical quality control were highlighted as profitable tools for quality improvement and cost reduction necessary to stay competitive.

One of the most recognized fact-finding applications is the process capability analysis. All of industry is acknowledging that variation is inevitable. The process capability analysis is the quality control technique for determining "how much variation, and around what average?"

What does a process capability study look like? Usually, a pictorial presentation is easily understood when presented as shown in Fig. 1.

This curve tells the following facts:

1. The variation pattern is consistent; that is, in a state of statistical control.

2. The total variation of the lathe is 0.0120, which is greater than the tolerance (0.010).

3. The lathe is being operated to the high side; specificially, 0.003 above the mean dimension.

4. Under current operating conditions, approximately 16% of the product is out of upper specification limit and will probably require reworking (determined by computing the area of the normal curve in the out-of-specification segment).

Knowing this information, management is now in

Quality Control Panelists

Today, quality control is an integral part of the production team. The application of statistical methods to manufacturing problems has brought about a new understanding of shop capabilities.

This article tells how cost savings and quality improvements are accomplished by the noninspection applications of statistical methods. It is drawn from the discussion between the forum participants and the following panel:

Panel Leader:

E. L. Fay
Deere & Co.

Panel Secretary:

Dale A. Cue
A. O. Smith Corp.

Panel Members:

G. W. McElrath
University of Minnesota

C. E. Hoover
Perfect Circle Corp.

J. J. Cordill
International Harvester Co.

W. F. Kohl
Allis-Chalmers Mfg. Co.

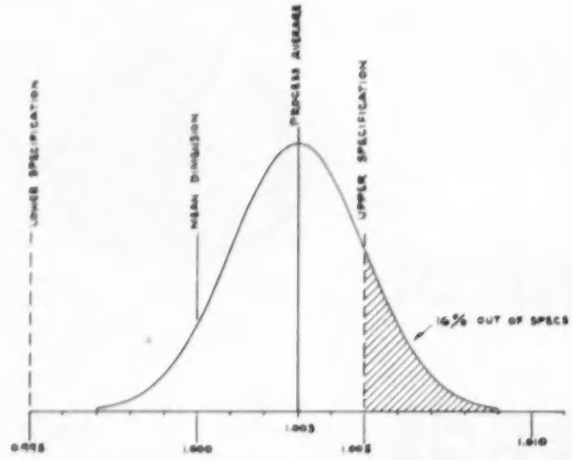


Fig. 1—Process capability study. Machine: lathe; part: idler shaft; specification: 1.000 in. plus or minus 0.005 OD

a position to take action. These are the possibilities:

1. Reset the tool to the mean dimension. This will reduce the out-of-tolerance product from 16% to 4%. However, the process capability still exceeds the tolerance.

2. Recondition the lathe to bring the total variation within the 0.010 tolerance.

3. Change the specifications to coincide with the process capabilities.

4. Transfer the job to more capable equipment.

5. If economic conditions demand, leave as is, and screen defective material.

How was this information obtained?

There are several possibilities for establishing process capabilities. If the process level is adjustable or manually controlled, a check of consecutive pieces on one tool setting will tell the story.

If the tool is preset, such as a broach, or if one is checking an assembly stackup among a group of components, the pieces may be selected at random. The key is to determine the standard deviation of the process. The standard deviation is a measure of variations and can be calculated as shown in Appendix I.

After determining the value of the standard deviation (σ), we know that 6σ will include approximately 99.7% of the product and is considered to be the total variation. The only precaution necessary is to assure that the process is normal; that is, in a state of statistical control. This can be determined visually from the histogram comparison to the normal curve or by another statistical technique, the chi square test.

The applications of process capability studies are many. These are the most prominent:

1. Evaluating individual manufacturing operations.

2. Evaluating assembly capabilities due to component parts stackup.

3. To determine if reconditioning of old equipment is necessary.

4. To determine compatibility between engineering tolerance and machine capabilities.

5. To select the proper equipment for the job.

6. To determine purchased machine tool capabilities as compared to purchase order requirements.

7. Evaluating vendor capabilities.

This list is inexhaustible. If the variation is measureable, then a process capability analysis is a valuable tool.

Process capability studies have proved themselves. Manufacturing, product engineering, planning, methods, mechanical engineering, purchasing, production control, and above all, management in general have benefited from this type of factual information. It is not essential that everyone understand how process capabilities are developed but one should have confidence in the data presented.

To keep process capibilities current, some companies are requiring that a process capability study be made prior to the time study on new jobs. In some incentive shops a piece-work rate is not established until the equipment has been determined to be satisfactory. This evaluation of processes has been carried even further to include establishing operator gaging frequency necessary to control the process level. The gaging frequency is governed by the amount of variability of the job. As an aid to the operator average ($\bar{X}$) and range (R) charts, sum and range charts, and reset-run cards are furnished on critical operations. After such procedures are established, the production supervisors usually refuse to accept a job until a process capability check is made and the gaging frequency is established.

Periodic recheck of process capabilities are made in most shops. On operations where $\bar{X}$ and R charts are maintained, it is simple to determine process capabilities by calculating the standard deviation by $\sigma = \frac{\bar{R}}{d_2}$, using the range data from the chart.

By conducting capability checks in conjunction with time studies, quality control is able to accomplish preventive action, thus eliminating scrap and repairs, improving quality, and increasing productivity.

Process Capability Checks on New Machines

A spokesman of the machine tool industry indicated that his company was encountering an increasing trend in use of process capability checks on their machines. In some cases the purchaser requires the equipment be evaluated before shipment, while in other cases the capability studies are performed after the original installation.

The capability requirements of machine tools in most cases are being stipulated on the purchase order. Some master mechanics and mechanical engineers are establishing tool setting allowances for the operator and are subtracting this allowance from the engineering tolerance; this then is stipulated as the machine capability required.

This application is spreading rapidly, which verifies that industry is adopting a preventive attitude toward quality. The concept of designing, engineering, and planning quality into the product so that manufacturing will have the facilities to do a quality job is appearing in reality. Under these circumstances the quality control job is reduced to verifying that acceptable quality is being produced.

Action

The publication of information, such as made available through process capability analysis is not enough. Someone must take *action*. The success of quality control depends on the ability to stimulate action; permanent and preventive action. To achieve the corrective action imperative for satisfactory results, most companies are developing the committee approach. This is understandable when we consider the variety of departments influenced by the presentation of cold, hard, facts about the manufacturing processes. The committees take many forms; quality improvement committee, manufacturing review boards, action committee, cost reduction teams, and others, but they all are striving to reduce costs and improve quality. The most significant feature of the trend to the committee approach is that a member of the top management is the chairman of these groups. However achieved, the fact that action is being taken is the only measure of success and results.

Attitude

Industry's attitude toward statistical quality control is a critical factor. Usually someone is "put on the spot" when process capabilities indicate inadequacies. This condition can easily cause an antagonistic attitude toward quality control. It is essential that management and shop supervision recognize statistical quality control as a service. Facts and analyses presented by it are not intended to crucify anyone but are intended to aid industry in realizing its weakness so that improvement can be accomplished through corrective action. One of quality control's biggest challenges is selling its program in a constructive manner.

Cost savings and quality improvements which have resulted from statistical analysis and applications of statistical quality control are selling most quality control programs. The advent of scientific management offers it an opportunity to take its proper place on management's team.

Inspection Cost Fallacies

In some instances statistical quality control has been oversold. Even though statistical methods for analytical purposes will apply almost anywhere, they are not an industrial panacea. Management action is indispensable.

One of the greatest fallacies in industry's understanding of quality control is that it will decrease inspection cost. This statement is essentially true; however, in some manufacturing plants inspection has been understaffed and is inadequate. These inspection shortcomings have been realized when quality has been appraised on a scientific basis. In almost all cases, management was not willing to continue the quality risks that its previous inspection systems would allow. The results were a tightening of inspection standards and a substantial increase in coverage with a temporary increase in inspection costs. Through more efficient methods, such as acceptance sampling, the inspection costs maintained about the same level while improved quality, greater coverage, and better control were achieved at no inspection cost increase. Generally, overall manufacturing costs decreased. Where the shop had adequate coverage prior to statistical quality control, then reduced inspection costs can be accomplished through the use of statistical methods.

Economic Level of Quality

All of industry today is trying to establish the economic level of quality. The original concept of classifying defects by their relative importance and the assigning of acceptable quality levels to products has assisted in removing a portion of the intangibility of quality. The big question in the minds of executives and quality people alike is, "Where does quality improvement cease to be economical." So far no one has established a method that will select the optimum economic quality level on a realistic basis. Yet industry knows that perfection is impossible and asks "Where shall we draw the line?" It appears that customer complaints, warranty and policy expenditures, product service costs, and general customer acceptance of the product will continue to be controlling factors of economic quality.

Even though statistical quality control has done its best to standardize acceptable quality levels to manufacturing, these standards will have to be periodically revised and reviewed. However, quality control establishes the quality level manufacturing is capable of producing consistently. This information aids management to establish realistic economic quality standards. With the return of the competitive market, quality standards are and will be dictated by the consumer. These standards will change, and it is up to quality control to keep abreast with the endless evolution of the quality-cost jigsaw.

Quality Criteria and Responsibility

A compromise between per cent defective and the dollar is the most universal criteria of quality. In assigning acceptable quality levels, we find that the economic result of allowing a particular defect to reach the customer must be considered. As a comparison, some minor defects in a cover plate can be allowed, whereas, no cracked axles could be allowed on a finished tractor. The defective cover plate would not result in a serious customer complaint. The cracked axle would cause a serious customer complaint, a loss of confidence in the product, and also a considerable expenditure to repair the unit.

Who is responsible for quality—inspection or manufacturing? It is almost unanimous in industry today that manufacturing is solely responsible for producing a quality product. The responsibility of quality control or inspection is to control the outgoing quality to the customer. A coresponsibility of quality control is to advise manufacturing of quality discrepancies and to suggest permanent, corrective measures. As one quality control administrator put it, "I don't believe an inspector has made a good piece yet."

The inspector is an interpreter of quality require-

ments for the manufacturing organizations. Occasionally, manufacturing may try to transfer its responsibility for quality by requesting excessive inspection, usually 100%, so that if defective material reaches the field, the inspection group is at fault. Such a condition is economically impractical and reveals a complete misunderstanding of the quality control philosophy. Correction of the causes of inferior quality at the lowest possible level of management is the ideal of managerial quality conscientiousness.

In-Process Control

The application of in-process control, the control of quality at its source, is becoming more evident. In rare cases in-process control is replacing final acceptance inspection. The most utilized tool in the in-process control theme is the $\bar{X}$ and R chart. This type of chart reflects the ability of both the man and the machine. By putting an $\bar{X}$ and R chart on each individual operation of a production line, the production is accepted as long as both the average and range charts are in control. The average ($\bar{X}$) charts indicate the level at which the machine is operating and the range (R) charts indicate the amount of variations that exist in the machine. Usually the operator is responsible for controlling the tool setting. Therefore, you are charting his ability to establish and maintain the process average.

The greatest advantage of in-process control is that a malfunctioning machine or an improper tool setting is discovered almost immediately. This reduces scrap and repairs. The presence of the $\bar{X}$ and R chart on each machine is an aid to the machine operator and production supervision. The big "if" of this system is that each operation must be capable of maintaining the engineering tolerance. This stumbling block is the cause of in-process control's limited use. The use of process capabilities can remove this "if."

Engineering Tolerances and Gaging

Much criticism of the engineering department has been provoked due to unrealistic tolerances. An example of the confusion regarding tolerances was expressed as, "Engineering sets the tolerance, manufacturing used a different tolerance in the shop, and inspection used another to accept or reject the material." This picture may be exaggerated; however, it reflects an undesirable condition. In many instances our engineering departments may be basically wrong about tolerances but the fault is not exclusively their own. Frequently, inspection and manufacturing tell engineering that they can maintain certain tolerances but when they get into production, they find they cannot. Inspection and manufacturing are then guilty of having given the engineers wrong information about shop capabilities. This uncertainty and lack of knowledge caused engineering to lose confidence in the shop's ability to produce. Consequently, engineering required stricter tolerances than were absolutely necessary because they knew that the tolerances would be violated.

Since quality control and manufacturing know more about their processes through conducting capability analyses, engineering is now re-appraising the tolerance situation. This approach will ultimately result in realistic tolerances and a mutual understanding of the shop ability to produce with the equipment provided. This is a healthy condition. In fact, planning and engineering are requesting more information from quality control about process capabilities. Eventually, engineering tolerances will become more practical and will agree with shop capabilities.

There isn't any argument on this score in quality control quarters; more and better measuring gaging is needed. Under present-day concepts the go, no-go gages are becoming less useful for control purposes.

Modern quality control is not a sorting or rejecting proposition. When sorting is necessary, the go, no-go gage is the most practical and economical to use. The attitude of current statistical quality control practices is not to ask, "Is it out of specifications?" but, "*How much* is it out of specifications?" This question can only be answered with the variable-measuring gages. This means a tremendous increase in the original gaging cost. However, since a great portion of measurement gaging equipment is convertible and is adjustable to a variety of similar products, a multipurpose gage program can be developed. Without measurement gaging, the success of statistical quality control is retarded and impaired.

Research and development on plastic gages are being watched very closely. If plastic gaging applications are successful, savings in gaging cost will be possible. The applications to date have been on an attribute (go, no-go) basis. Such items as hole location, contour, and clearance, can be checked with plastic gages. The foundry and stamping fields seem the most interested in this program. The metals industry in general should keep an eye on plastic-gage possibilities.

Deviations from Specifications

The quality manager and the chief engineer both will confirm that they are not worried about known deviations from specifications. Deviations that are not brought to light and are allowed to exist cause complaint epidemics and serious trouble. Quality control and engineering recognize that perfection is too costly and impractical and a certain number of deviations are to be expected. Steps to put deviation requests on an organized, formal basis are being initiated in many companies. The motive for requiring deviation requests on a formal basis is to allow engineering and quality control an opportunity to evaluate the effect the deviations will have on consumer acceptance. Engineering should approve deviation requests on discrepant material. Usually, the number of discrepant pieces or the length of time the deviation is authorized is shown on the formal request. This eliminates the possibility of customer complaints. Frequently, engineering, quality control, or sales will contact the customer if the product is a subcontractor item, and request authority to ship the material in question. Both the manufacturer and the customer prefer this approach. Here again, having the facts and knowing your product make control and quality assurance possible. This source of information also makes

corrective action possible and lends support to tolerance reviews.

Rejected Material and Salvage

A majority vote was cast that manufacturing should be responsible for rejected material from both the sorting and repair standpoints. If allowed under labor-company contracts, the individuals responsible for producing the unacceptable material should be required to perform the sorting and the repair or salvage operations. Inspection reversed its stand on specialized salvage techniques where considerable skill or training is required to ensure satisfactory rework results. In these instances, inspection maintains its own salvage department with capable personnel and the required equipment. However, all the salvage costs performed in these salvage departments are charged against the offending manufacturing department.

Under no circumstances should scrap and repairs be allowed to accumulate. A scrap or salvage committee usually reviews discrepant material daily and makes the final material disposition and recommends the method of reclaiming salvable material. Surprisingly, when qualified people review discrepant material, it is discovered that some of the salvage costs exceed the actual value of the part. By investigating the causes of scrap and repairs, substantial savings result from corrective action, eliminating the cause of the discrepancy at its source.

Inspection Procedures

Many companies are establishing inspection procedures. The statistical quality control wing of inspection is usually delegated this responsibility. At this point, it must be said that quality control is normally under inspection's jurisdiction or has replaced the inspection department. Since the advent of quality control, statistical inspection techniques have replaced previous inspection methods. As a means of applying these statistical inspection methods so that all phases of labor and management might successfully perform the mechanics of statistical quality control, cookbook-type procedures are furnished. Here the trained and qualified quality control engineers, in collaboration with the experienced inspection and manufacturing supervisors, develop the appropriate methods to fulfill the inspection needs. Such an appraisal of quality and protection requirement has, in many companies, disclosed previously unacknowledged deficiencies. It is surprising, but the preparation of procedures will reveal that inspection may be performing many noninspection functions and is neglecting some essential inspection functions.

Inspection procedures establish:

1. What kind of inspection.
2. How much inspection.
3. Quality standard—what to check.
4. Acceptance-rejection decision criteria.
5. Fixes corrective action responsibility.

A procedure that specifies these five basic items eliminates a great deal of the personality conflict normally encountered in inspection-manufacturing relations. This is especially true when the quality control procedure is approved by the plant manager and manufacturing superintendent.

Quality control procedures establish quality policy and through them the inspection job is better understood, recognized, and performed.

Inspection Audits

Some multi-plant enterprises conduct audits of the individual plant inspection procedures. The personnel conducting the audits are normally specialists in statistical quality control and inspection methods. The audits are conducted on the premise that each plant knows what is best for itself and the inspection procedure reflects individual plant requirements. Therefore, an audit consists of two phases:

1. Does the procedure conform with operating practice?
2. Does it utilize the most efficient methods?

It is mandatory that the audits be conducted in a constructive manner. Their purpose is to improve the inspection function through realistic appraisal and constructive criticism. After an audit, the auditor reviews the discrepancies with the chief inspector and the factory manager and discusses his suggestions for improvement with them. The local management, naturally, may and probably will disagree with some phases of the auditor's findings. On those points where agreement is reached, a plan of action and a tentative timetable for the completion of this action are established. The items that are contested are investigated further. Most executives feel that such audits assist considerably in maintaining a hard-hitting, highly efficient quality control organization.

Acceptable Quality Levels

Quality people all agree that defects must be classified by their relative importance, and that acceptable quality levels should be assigned before an acceptance-rejection criterion is established. This applies to all products, both purchased or manufactured. The acceptable quality level usually is arbitrarily based on past experience and the function of the product. However, engineering is playing an increasingly important part in establishing acceptable quality levels. Most often, they are assigned to the defect classification rather than the part.

This approach is utilized by most companies on purchased material as the most effective means of defining quality standards to the vendor. Widespread use of acceptance sampling in receiving inspection has been the net result.

Vendor Rating

The ability or inability of a vendor to meet quality standards is easily evaluated by comparing performance versus acceptable quality level requirements. This type of a comparison has been used to rate vendors on a competitive basis and is furnished to the purchasing department. Purchasing is using these quality ratings for choosing vendors for new items. In fact, some purchasing departments have canceled contracts because of unsatisfactory quality disclosed by reports on vendor quality. Now more

than ever, purchasing is considering quality as well as unit price on purchased material.

Vendors are very receptive to quality rating and similar performance reports. This information gives their sales department, factory manager, and quality manager a factual appraisal of their products. The vendor appreciates this approach and usually does his utmost to give the purchaser what is wanted because, for the first time, he knows objectively what kind of quality is required.

The net result of appraising vendor's quality is a family of high caliber vendors, competitive from both the quality and price viewpoints.

Short Runs

Short runs are probably one of the most difficult types of manufacturing operation to control. However, statistical quality control is a natural for getting the most information out of a limited amount of data. One of the big secrets of success is developing a good record system. It may take longer to accumulate the data needed to determine the product quality level, but if an individual part quality history is formulated, a factual evaluation of quality problems is possible.

The process capability analysis is an excellent tool on short runs regardless of how small the sample size. The use of statistical analysis on small samples will give the best estimate possible of the product and the process. Since similar products are run on the same machine in the job shop, then why not use the $\overline{X}$ and R chart and develop process capabilities? There is only so much variation in a lathe or a boring machine, and the variation pattern should be essentially the same for similar jobs. Let's suppose that we bore a 1.000-in. inside diameter in a water pump body, change the setup and bore a 1.370-in. inside diameter in a different water pump body. If the process capabilities are radically different, there is evidence of an assignable cause. Knowing this, we should investigate the job and determine the reason for the excess variation on the malfunctioning setup.

Psychological Value

Whether statistical quality control is applied to short runs or continuous production, the psychological value of control charts will influence quality improvement. Inherently, most men want to do a good job. To the man on the job, a control chart is a report card on his ability. It is natural that the machine operators and the assemblers take pride in a control chart showing good performance. The labor unions also like the control charts, especially the $\overline{X}$ and R chart. These charts indicate the performance of the people they represent; a performance record that is not biased or prejudiced by anyone's opinion, and also shows the capabilities of the machines.

The use of colored lights, siren, horns, and other signal systems when a process is out of control, or approaching it, has also proved their merit. These communication systems all are signaling that action is necessary—a psychological appeal. In shops that are using these devices, the results have verified their value.

Psychologically, statistical quality control is one of the most effective tools being used in industry.

Summary

Statistical quality control is not exclusively an inspection tool. The statistical techniques used by quality control people have broad applications throughout all phases of industry. The bread and butter applications are the analytical or noninspection phase of statistical quality control. Here the byproducts pay dividends.

Because of the great analytical value of statistical quality control, the quality control department is becoming an information center. Management recognizes the value of this information as results are only achieved through management action.

The adoption of statistical techniques and methods to other phases of industry has opened up a new frontier for savings and improvements.

Appendix I

$$\sigma = \sqrt{\frac{\Sigma(X - \overline{X})^2}{n-1}}$$ (For sample of 30 pieces or less)

$$\sigma = \sqrt{\frac{\Sigma X^2}{n} - (\overline{X})^2}$$

(For sample of more than 30 pieces)

σ = Standard deviation
Σ = Sum of
X = Individual measurement
$\overline{X}$ = Arithmetic mean of sample checked
n = Number of pieces in sample

The basis of the quality control engineer's process capability analysis is the normal curve. As shown in Fig. 2, the normal curve tells us this:

68% of the product falls within $\pm 1\ \sigma$ limits.
95% of the product falls within $\pm 2\ \sigma$ limits.
99.7% of the product falls within $\pm 3\ \sigma$ limits.

(The report on which this article is based is available in full in multilithographed form together with reports of six other panel sessions of the SAE National Tractor Production Forum, held in Milwaukee, Sept. 13, 1954. This publication (SP-308) is available from SAE Special Publications Department. Price: $1.50 to members, $3 to nonmembers.)

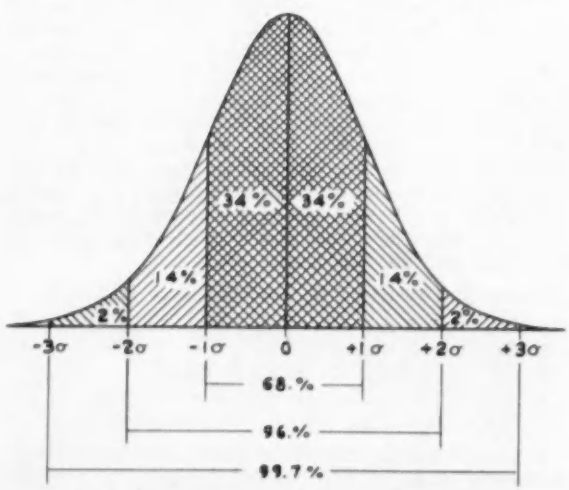


Fig. 2—Approximate areas for typical normal curve

Mechanization and Flexibility

are twin goals at General Electric's Jet Engine Plant

JET engine production at GE's Evendale, Ohio plant is methodically progressing towards increased mechanization. At the same time, plant layout and methods are being kept very flexible to meet the exigencies of jet engine manufacturing. At present the assembly and materials handling operations are mechanized with power conveyor lines. Some small parts fabrication is becoming more completely automated.

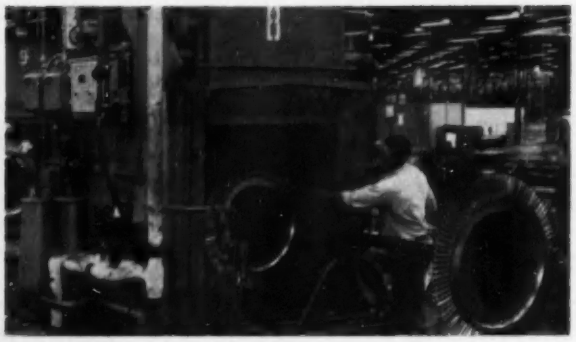
This progressive mechanization was evident to the SAE members as they toured the Jet Engine Assembly and Testing Plant during the SAE Golden Anniversary Production Meeting in Cincinnati, on March 16.

They saw that the unique problems of jet engine manufacturing are evolving techniques of mechanization different than in the automobile industry. Several million engine parts must be routed through receiving, inspection, storage, assembly, test, and shipping at a very high production rate.

Less than 1% of the parts are interchangeable between engine models. Design is constantly changing and there are daily revisions in dimensional tolerances brought about by the rapid developments of the aircraft industry. Therefore, plant facilities must be flexible to handle changes in methods and procedures; and they must be adaptable to quick changes in production rates to meet defense needs.

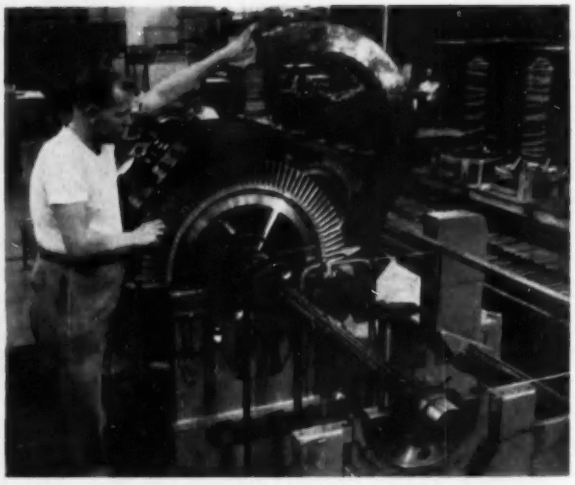
The flexibility and mechanization of these facilities were pointed out by GE guides during the tour and are described in the following pages.

1. **INCOMING MATERIALS** are loaded on carts towed by overhead *towveyer* along full length of receiving dock and into storage area. Inside, parts are transferred to roller conveyors.

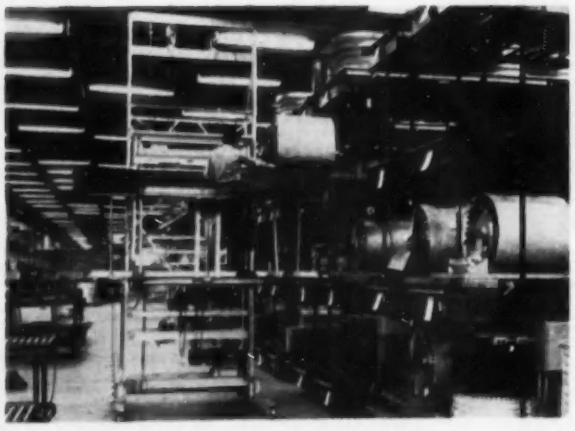


2. **AUTOMATIC WASHERS** clean turbine wheels before inspection. Spot check inspection, based on statistical quality control, double checks inspectors at vendor plants.

3. **INDUSTRIAL DENTIST** checks thousands of blade teeth for nicks. In a J47 jet engine they "chew up" three tons of air per minute.

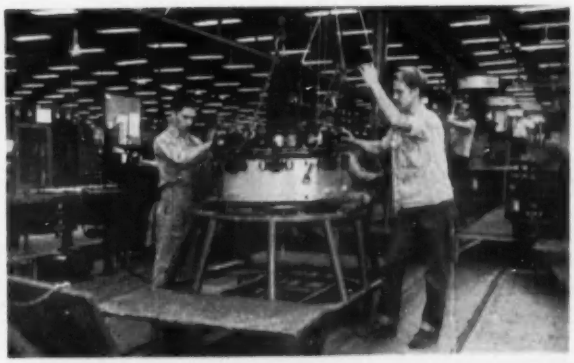


4. **DYNAMIC BALANCING** up to 500 rpm is essential. Hand grinders are used here to make corrections.

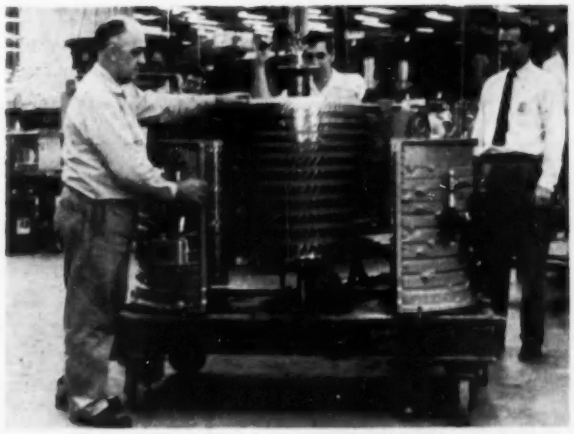


5. **MAJOR PARTS STORAGE** (at right) consists of 67 belt-powered roller conveyors in tiers of four. Parts on pallets move automatically along conveyors, and are removed at the other end by this elevating transfer car. Thus, less personnel and 20% less space are necessary. Parts are used on a first in—first out basis.

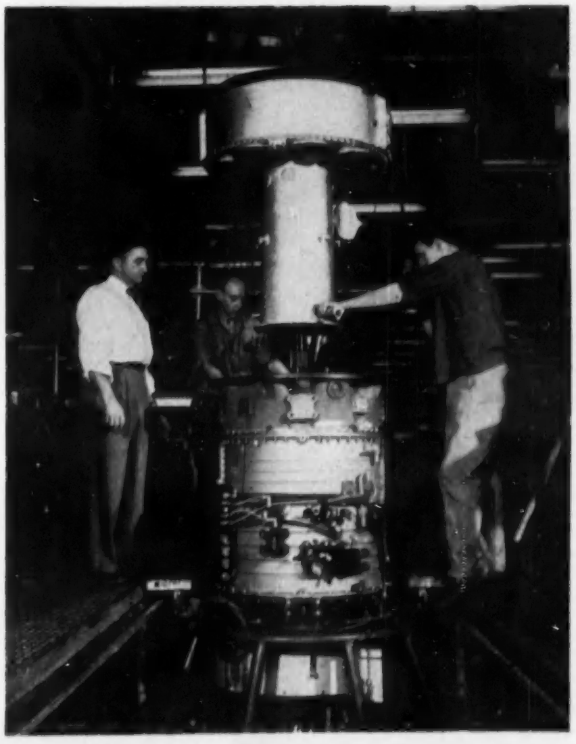
6. **FORWARD ENGINE FRAME** is assembled on a dolly which follows a closed loop floor track in subassembly area. Power hand tools are used wherever possible.



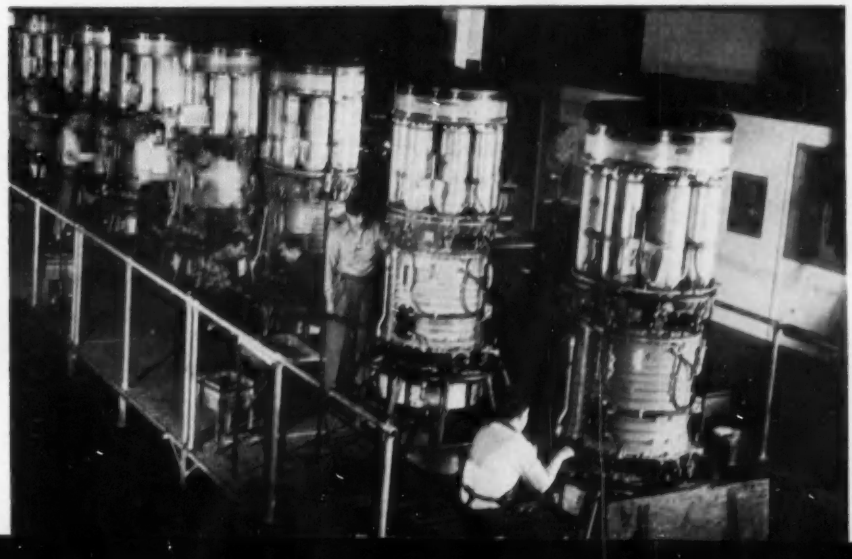
7. **AT START OF GREENLINE** the subassembled forward frame is placed on the conveyor dolly. Overhead winches provide power for lifting heavy parts.



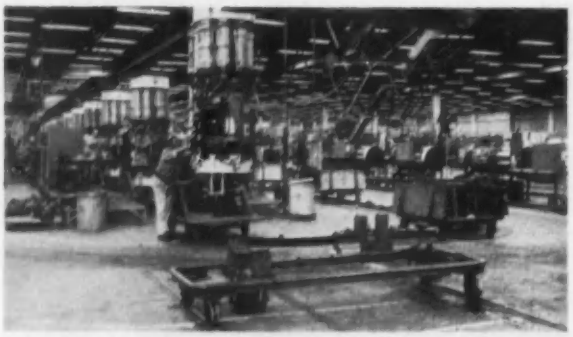
8. **AT ANOTHER SUBASSEMBLY STATION** the compressor rotor is put into the stator. Blades fit closely so special jigs are used to help alignment.



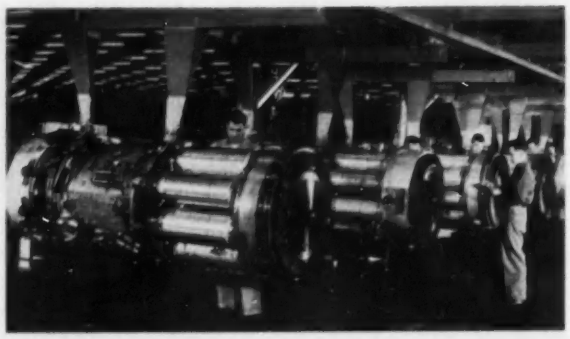
9. **FURTHER ALONG GREENLINE** (at right) the compressor section is assembled on top of the forward frame, then the aft frame is lowered into the compressor section. Movable rolling platforms between the engines provide a complete work-circle around the engine.



10. **VERTICAL ASSEMBLY** method saves space, makes work areas more accessible, and simplifies alignment problems. Combustion burners, on top of the engine, are brought out from storage and subassembly stations in matched sets of eight on an overhead conveyor.

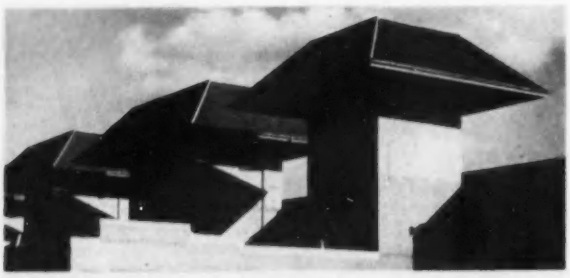


11. **AT END OF VERTICAL ASSEMBLY LINE** engine is removed from the dolly which moves around a closed loop to enter the work circuit again. Horizontal dolly, in foreground, has compressed-air jack to raise engine several feet.



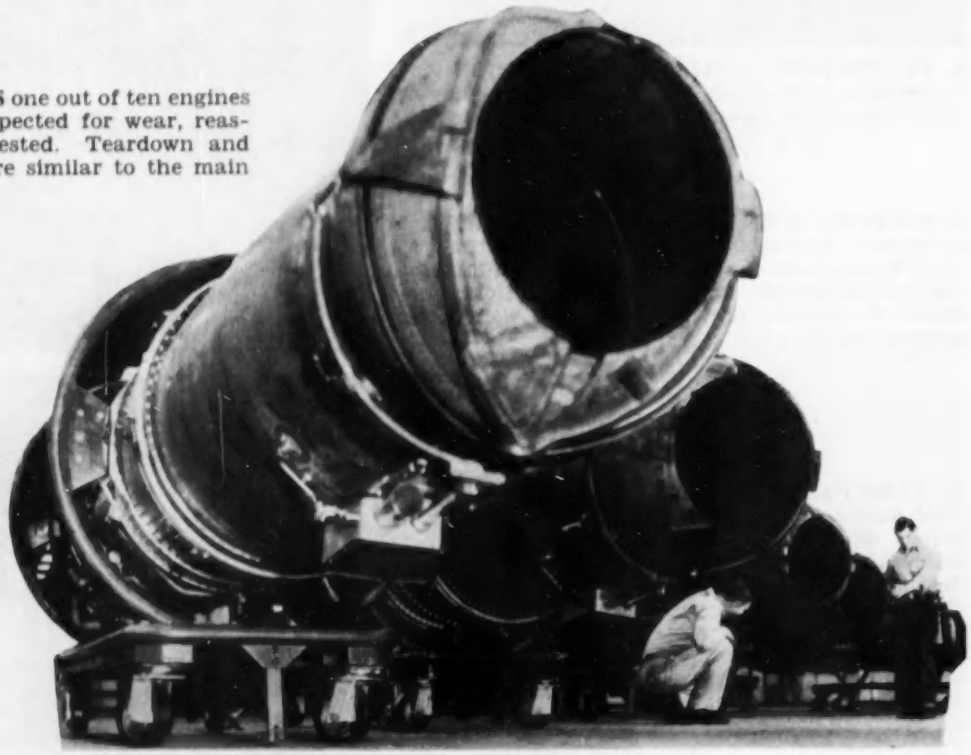
12. **ON "GRAPE ARBOR,"** or horizontal assembly line, the conveyor chain runs overhead. Hardware, tail cones, and afterburners are added here. Production rate can easily be increased by adding more men or work stations along the line.

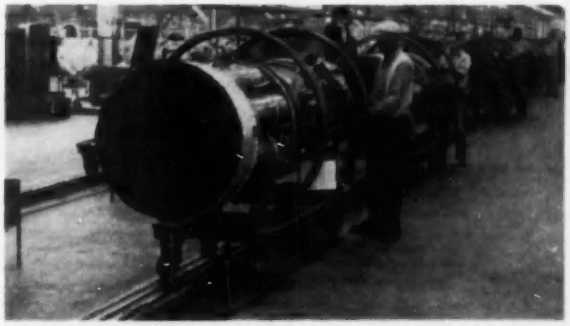
13. **ASSEMBLY IS COMPLETED** and the engine is towed to its test cell. A special dolly is designed to accommodate the engine throughout the test operation.



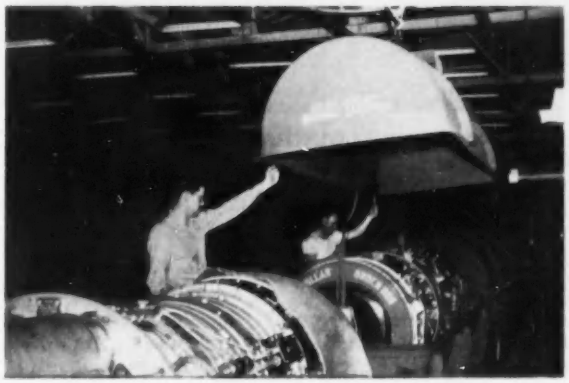
14. **TEST CELLS** are massively constructed of special concrete to withstand temperatures over 1000 F.

15. **AFTER TESTS** one out of ten engines is torn down, inspected for wear, reassembled, and retested. Teardown and rebuildup lines are similar to the main "greenline".





16. **HORIZONTAL ROLL-OVER DOLLIES,** like these, are hooked to a drag chain and take the engines down the preparation-to-ship line. Engine is weighed, coated with preservative oils, and center of gravity determined.

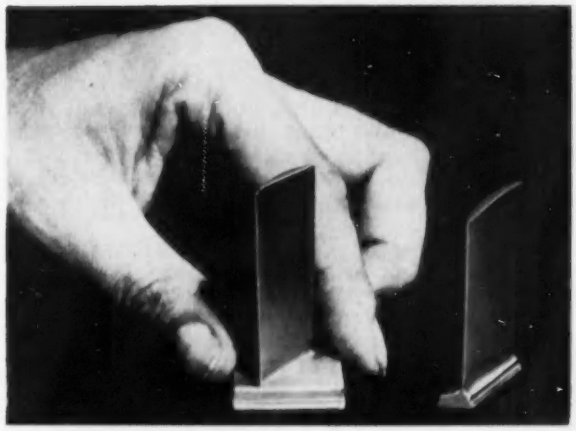


17. **SHIPPING CONTAINER LID** is placed on the container. Tail cones and afterburners are packed similarly and shipped on the same flatcar.

18. **RICE HULLS AND GROUND WALNUT SHELLS** are air-blasted on compressor blades to clean off surface dirt during overhaul. Engines are returned to Evendale for overhaul from the field.

Blade Fabrication is Highly Mechanized at G.E.

Compressor stator blades are small and uncomplicated, but require close tolerances to a thousandth of an inch, no defects, and a production rate of hundreds of thousands per month. Evendale uses automatic machines, conveyor belts, transfer devices, and human hands and eyes in fabricating the raw material into a finished blade.



AUTOMATICALLY FABRICATED blade (left) costs 55% less than old forged blade (right). Base and airfoil blade are made separately, saving 39% critical materials.

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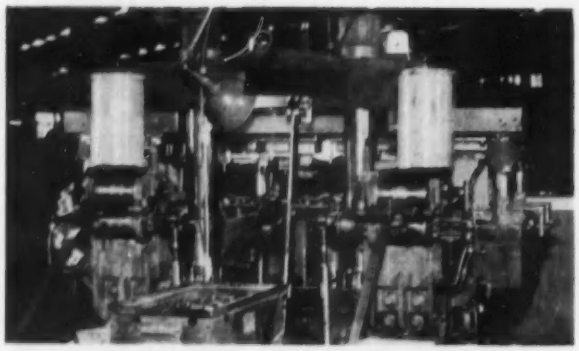
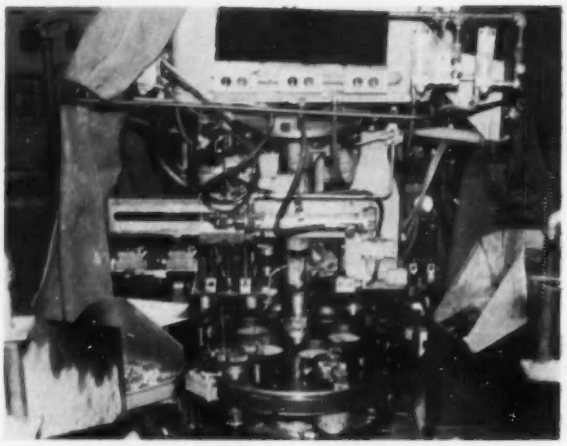
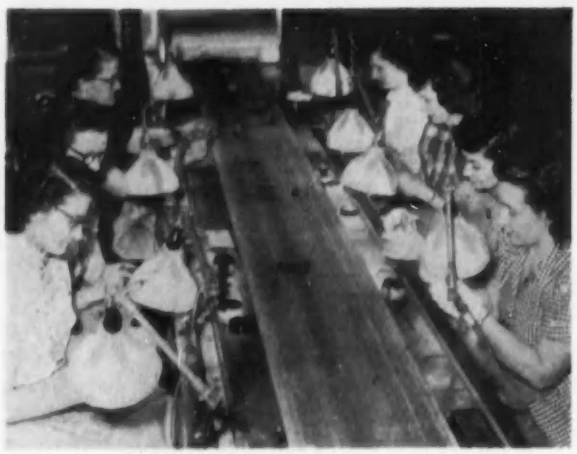


AUTOMATIC "DIEING" MACHINE (left) takes in two reels of precision-formed strip steel. It forms, punches, and presses the two pieces together, and ejects a completed base section. Machine can be adjusted to make bases of different size.



AUTOMATIC WELDING MACHINE (above) joins the base and airfoil together. Pieces are automatically picked up from the rotating table and deposited in a tray for fluxing and heat-treatment in a furnace. From furnace, blades go to a series of grinding machines.



VISUAL INSPECTION (left) on conveyor belt discovers flaws not detected by a magnaflux machine. Then blades are automatically loaded into boxes.

Tandem Driving Axles . . .

. . . may or may not be an economy. It depends on the particular operation. Hauler must know his costs if he would choose equipment wisely.

Based on paper by **E. E. Siegrist,** Timken-Detroit Axle Division, Rockwell Spring & Axle Co.

TANDEM axles are desirable only if they will yield more revenue and profit because of a better ton-mile factor. In many operations they are not justified, while in a large percentage of four-wheel operations undoubtedly they would be highly desirable.

On a nation-wide basis, the two-axle tractor and tandem-axle semi-trailer is the most favored rig for hauling maximum permissible gross train loads. It is not practical for the heavier legal loads of the far west, but it is the accepted standard in more than 30 states. In 42 of the 48 states it can haul anywhere from 50,000 to 68,000 lb legally.

The supremacy of this rig is now being challenged by proponents of an extra axle on the tractor even when no increase in gross train weight can be obtained. They realize that legal axle loads are tougher to come by than legal gross loads and that a cushion of loading flexibility may be worthwhile. The situation is aggravated by the trend to lighter density loads and the resultant rush to obtain maximum cubic capacity.

Experts say that regardless of the formula in effect over a given route, it is difficult for the dry freight hauler invariably to control the loading of the rear axle on 4 × 2 tractors where there is an 18,000-lb limit. Depending on individual conditions, therefore, the installation of extra equipment,

properly selected will avoid the hazard and expense of reloading cargo enroute, and will guarantee that maximum payload is on the road at all times.

With conventional 4×2 equipment the hauler is inclined to become conservative, especially if he has had a brush with the law, hence he may be running 3000 lb shy in payload. With a 10¢ per ton-mile rate, a gain of 3000 lb is equivalent to a gain of 15¢ per mile, and the question of spending money for extra axle equipment becomes academic. The added cost can be paid for in less than two months.

In dry freight hauling there are two types of loading—selective or controlled, and water-level or uncontrolled. With the former type, skillful handlers distribute the load properly to assure proper axle loading. They may even use sliderule calculations. Some think the extra payload that can be carried justifies the practice; others claim that equipment is tied up too long, and errors are difficult to avoid and costly to correct.

With water-level or uncontrolled loading, cargo is stowed without regard to axle loading and corrections are made after weighing at the docks. It is acceptable practice for heavy, concentrated loads.

If the general run of cargo lends itself to selective loading, it can be shown that a single-axle tractor and tandem-axle trailer should be adequate to give maximum payloads within GCW limitations. But if neither cargo nor loading procedure lends itself to selective loading, it is wiser to invest in extra equipment recommended by a truck manufacturer or reputable equipment supplier.

It is imperative for every hauler to know his costs accurately. Only when costs are known can the operator determine what kind of equipment he must have, what kind will pay off, and how much he can afford in extras. There is no royal formula that can be applied successfully across the boards. (Paper "Design, Application and Usage of Tandem Driving Axles" was presented at SAE Texas Gulf Coast Section, Sept. 10, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Engine Test Cell . . .

. . . features suspended thrust stand to achieve accessibility and accuracy. Suspended stand simplifies engine installation and removal, and facilitates engine maintenance in cell.

Based on paper by **R. J. Vannelli,** Aircraft Engine Division, Ford Motor Co.

A SUSPENDED type of engine thrust stand was selected and developed as offering the best compromise to serve present and future engine types, provide engine accessibility, and achieve accuracy of thrust measurements.

Suspension of the engine with its centerline 6 ft from the floor level affords adequate clearance for working on lower portions of the engine, while rolling outrigger stands are provided for working on the upper portions. These outriggers are kept in the cell at all times for making engine adjustments, even during engine operation at idle. When not in use they are rolled to the rear of the cell along the side walls.

The movable portion of the stand hangs by means of four flexure plates or "ribbons" of stainless steel ⅛ in. thick, 7 in. wide, and approximately 5 ft long. (Fig. 1). This gives an extremely free moving stand, introducing no possibility of error in thrust measurement. With engine installed and test lines connected, the entire structure can be displaced ¼ in. by applying a force of 10 lb. No adverse yaw tendencies have resulted from this flexibility; however, in the original design, snubbers were incorporated at the rear of the stand to limit possible yawing.

The inverted engine cradle is made of 6-in. tubing having a ½-in. wall thickness. It is a fabricated weldment. Thrust measurement load cells are mounted on two 12-in. I-beam restraining members, one on each side of the engine. The engine is hoisted into its running position in the cradle by means of a single pneumatic hoist utilizing a pulley system at the front and rear of the engine so that the engine is raised uniformly. (Paper "Turbojet Engine Test Cell Design and Correlation" was presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 12, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers).

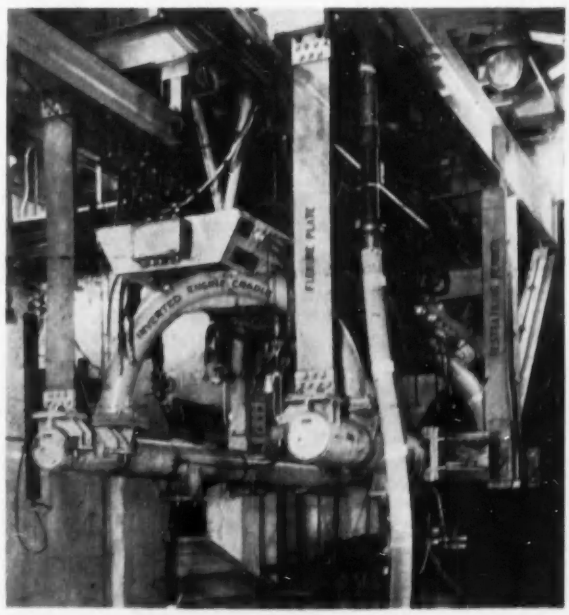


Fig. 1—Suspended thrust stand installed in new Ford test cell. Movable portion is hung by means of four flexure plates. I-beam restraining members carry the thrust measurement load cells

Little Economies in Materials

Ford finds that attention to two sometimes-neglected areas of materials management can save scores of thousands of dollars per year. One area is the slight cost differences between similar materials. The other is standardization of materials to simplify ordering and stocking.

1. Keeping Material Costs Down

FORD's philosophy is: Tell the manufacturing engineer what you want in the finished part. Let him decide how to achieve it at minimum cost. Leave to him the choice of process and material.

The documents at the right show how the Ford Motor Co. carries out this philosophy.

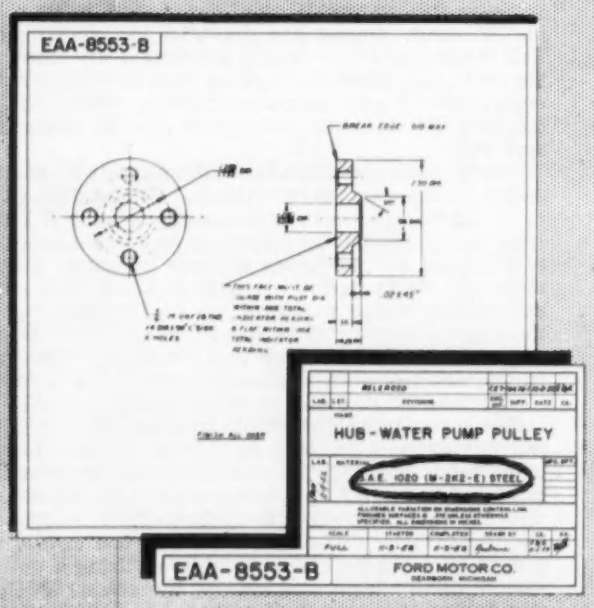
The design engineer has specified SAE 1020 (M-2K2-E) steel. M-2K2 refers to Ford's recommended practice on selection of carbon steels. This document gives the manufacturing engineer a wide choice. He determines first what process to use to produce the part. Then from the variety of permissible steels, he can pick the one easiest to work with.

The metal specification he makes out for the particular part sets forth his choice of material and special metallurgical requirements for it. Also recorded are other details such as sizes, tolerances, shipping instructions, and packaging information. Data recorded on this sheet become the purchasing authority when requisitions are issued.

To help the materials engineer specify needed metallurgical properties without adding unnecessarily to the price of the material, Ford has prepared the Raw Material Specification Practice for Carbon Steel Bars. Paragraph 2.4.1, for example, has this to say about coarse grain: "Specify when added hardenability is required on oil-quenched parts made from steels containing over 0.28% max. carbon. Specification of 0.10 max. silicon will automatically imply coarse grain steels and grain size need not be specified. Coarse grain not only avoids a price extra but increases machinability."

This kind of "dollar metallurgy" brings Ford real economies. For example, blueprints of rear spring leaves at first specified SAE 5160 with a maximum hardness of 300 Brinell to insure that the steel could

ENGINEERING DRAWING specifies a material, M-2K2-E steel in this case, that the designer knows has the strength to do the job. But drawing leaves exact choice of material up to manufacturing engineer. Drawing can be released months ahead of production deadline. The leeway it gives to manufacturing minimizes changes during pre-production period and the life of the model.



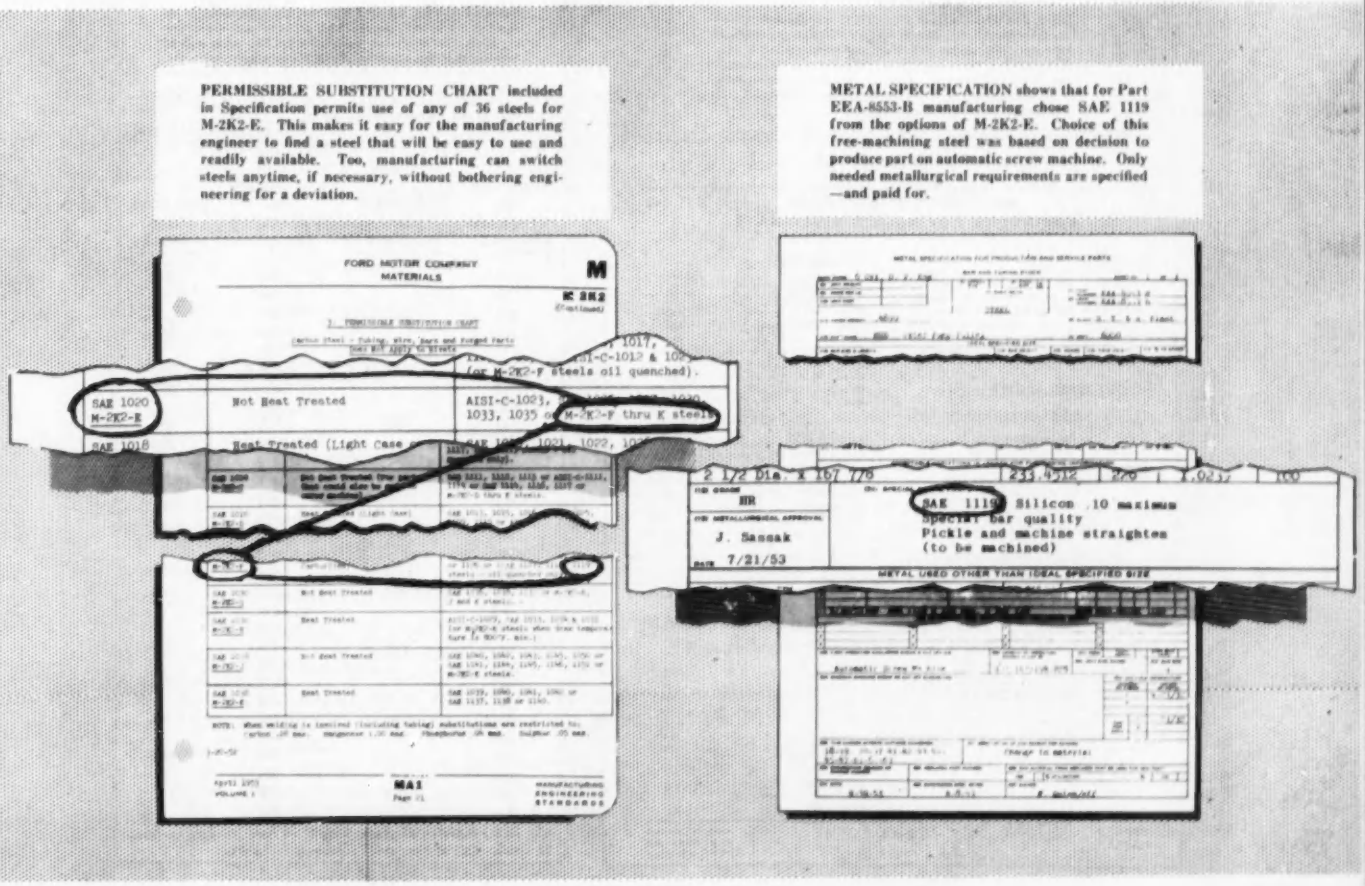
Yield Big Savings

Joseph Gurski, Ford Motor Co.

Based on paper "Materials Management" presented at SAE Golden Anniversary Production Meeting, Cincinnati, March 15, 1955.

PERMISSIBLE SUBSTITUTION CHART included in Specification permits use of any of 36 steels for M-2K2-E. This makes it easy for the manufacturing engineer to find a steel that will be easy to use and readily available. Too, manufacturing can switch steels anytime, if necessary, without bothering engineering for a deviation.

METAL SPECIFICATION shows that for Part EEA-8553-B manufacturing chose SAE 1119 from the options of M-2K2-E. Choice of this free-machining steel was based on decision to produce part on automatic screw machine. Only needed metallurgical requirements are specified —and paid for.



be blanked. Review indicated that the premium for specifying this hardness on all rear spring leaves would be $330,000 per year. Practically all this expense was saved by taking the risk of specifying merely "suitable for cold shearing and punching as outlined in AISI Steel Products Manual No. 10." This does not entail a price extra, yet almost always procures satisfactory stock.

2. Standardizing and Simplifying Materials

Ford reasons that wherever you can cut down on the variety of materials specified, you can save money all the way from the engineering department through purchasing, materials handling, and manufacturing. For one thing, you reduce paper work, thereby reducing both labor and elapsed time.

In engineering, standardization and simplification facilitate evaluation of new materials, reduce time spent in putting special information on engineering drawings, promote uniformity and accuracy, and reduce the number of requests for changes.

In purchasing, the work of writing, placing, and following up orders is lessened. Larger, more economic quantities can be purchased. Buying can be done on the basis of competitive bids and multiple sources established.

In materials handling, space is used more effectively. Delivery is expedited. And losses due to obsolescence are minimized.

Manufacturing becomes more familiar with the materials. Machinists work them more efficiently and create less scrap.

Ford achieves standardization of materials through company Recommended Practices. They appear in a variety of formats, but they have one thing in common. They all establish some attribute of materials as a basis for selection for various applications.

Wherever possible, these Recommended Practices follow SAE, ASTM, or ASA documents. The Manufacturing Research Department develops and periodically reviews the RP's, eliminating any near-duplicates that have crept into the system.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

THIS RECOMMENDED PRACTICE standardizes allowances for machining. Idea is to order a size large enough so that machining cleans off surface and leaves no seams—yet be sure size is not so large as to waste material and machining. This RP 4 serves as a guide to the many people involved in specification of bar sizes. Degree of risk to be taken is still left up to the manufacturing engineer.

FORD MOTOR COMPANY
MATERIALS

MACHINING ALLOWANCES FOR ROUND HOT ROLLED STEEL BARS — RP 4-1

1. SCOPE. This specification establishes the recommended machining allowances for round, hot rolled, carbon steel and alloy steel bars. Machining allowance is the amount of stock considered necessary to insure clean-up of seams, decarburization, etc., and is to be added to the finished part size when specifying material.

2. MACHINING ALLOWANCES.

2.1 Carbon Steel Bars (including SAE 1100 Series):

2.1.1 For parts where O. D. is important (i. e., hardness or finish requirements must be met).

Bar Diameter	Allowance (Dia.)
1" – 2"	1/16"*
2" – 3.5"	3/32"
Over 3.5"	1/8"

2.1.2 For parts where O. D. is not important:

Bar Diameter	Allowance (Dia.)
1" – 3.5"	1/16"*
Over 3.5"	3/32"

*If bar projects more than 10" from collet during machining, allowance shall be 3/32".

NOTE TO PROCESS ENGINEER. When processing shafts, piston pins, and other critically stressed parts, confer with Metallurgical Department of plant or Division concerned for determining proper size of stock to specify.

2.2 Alloy Steel Bars:

Bar Diameter	Allowance (Dia.)
To 5/8" incl.	.012"
Over 5/8"-7/8" incl.	.062"
Over 7/8"-1" incl.	.046"
Over 1"-1-1/8" incl.	.050"
Over 1-1/8"-1-1/4" incl.	.056"
Over 1-1/4"-1-3/8" incl.	.060"
Over 1-3/8"-1-1/2" incl.	.066"
Over 1-1/2"-2" incl.	.084"
Over 2"	.094"

NOTE. Allowances established by this specification are less than AISI recommendations for carbon steel bars and for alloy steel bars over 2 inches in diameter. Where it is considered mandatory to eliminate all risk that the part may not finish with acceptable surface, allowance may be increased to AISI recommendation. This means that the user is accepting some risk that bars will not clean up properly. However, the above allowances correspond to practice that has been satisfactory for some time.

AISI RECOMMENDED ALLOWANCES

Carbon Steel Bars

1-1/2"-3" incl.	1/8"
Over 3"	1/4"

Alloy Steel Bars

Over 2"-2-1/2" incl.	.106"
Over 2-1/2"-3-1/2" incl.	.144"

3-5-51

May 1951 VOLUME 1 — RP4 Page 1 — MANUFACTURING ENGINEERING STANDARDS

REDUCING THE VARIETY OF THICKNESSES in which sheet steel is ordered saved $73,000 per year, just on purchasing effort. By combining requirements of like thicknesses to increase ordering quantities, Ford enjoys a lower price, too. This saves another $12,000 per year on 0.075-in.-thickness steel alone. Even engineering departments save. They now letter decimal size only, instead of gage number plus decimal size, on their 25,000 drawings per year.

STANDARD ASA PREFERRED THICKNESS	SIMPLIFIED FORD STANDARD	STANDARD ASA PREFERRED THICKNESS	SIMPLIFIED FORD STANDARD
.236	.236	.042	.042
.224		.040	
.212	.212	.038	
.200		.036	.036
.190		.034	
.180	.180	.032	.032
.170		.030	.030
.160		.028	
.150	.150	.026	.026
.140		.024	.024
.132	.132	.022	
.125		.021	.021
.118	.118	.020	
.112		.019	
.106	.106	.018	.018
.100		.017	
.095		.016	
.090	.090	.015	.015
.085		.014	
.080		.013	
.075	.075	.012	.012
.071		.011	
.067		.010	.010
.063		.009	
.060	.060	.008	.008
.056		.007	
.053		.006	.006
.050		.005	
.048	.048	.004	
.045		.003	

ASA B32.1 contains 61 sizes. Simplified Ford standard contains 24 sizes. 96% of Ford steel purchased to 14 sizes.

Jet-Engine Blades, Buckets, and Vanes

Are Being Made by Variety of Processes

A. T. Colwell, Vice-President, Thompson Products, Inc.

Excerpts from paper, "Manufacture of Blades, Buckets, and Vanes for Turbine Engines," presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 12, 1955. This paper will be published in full in the 1955 SAE Transactions.

TURBINE-engine blades, buckets, and vanes can be manufactured by any of a variety of processes. Which one is used depends mainly on the material, configuration, component assembly, and specifications for the part. Consideration must also be given to tolerances, hardness, grain structure, surface finish, size of part, operating temperature, and reproducibility—to obtain dependable aerodynamic performance.

Methods being used to manufacture these parts include the following:

- Precision forging.
- Rough forging.
- Lost wax process.
- Lost plastic process.
- Frozen mercury process.
- Powder metallurgy.
- Fabrication.
- Reinforced plastic.

Precision Forging

Precision forging allows the airfoil to be forged to finish tolerance. The part requires only scale removal, a light, longitudinal polishing, and machining the root. Automatic machines do the polishing—0.0005–0.00075 in. being removed from each side of the airfoil.

All three parts—blades, buckets, and vanes—are being made by this method. To illustrate how it is done, we will describe its application to making a typical compressor rotor blade from type 403 stainless steel.

Slugs are cut from round bar stock, followed by extrusion and blockdown. The slug is approximately 12% heavier than the finished blade. Both the extrusion and blockdown operations are done in the same crank press (see Fig. 1). The slug is heated in an induction furnace, and extruded in the first die cavity to a shape resembling an automotive poppet valve—a long smaller diameter stem that becomes the airfoil and a larger diameter knob to be shaped into the root of the blade. Following extrusion, the part is transferred to a second die cavity and blocked down to the general size and shape of the blade.

Several years ago the die life was some 4000 pieces. By detailed attention to lubricants, die surface, die and punch temperatures, and shape of the extrusion, know-how has increased die life to some 20,000 pieces. Improved methods of die making have greatly reduced their cost, and attention to details of forging technique has reduced forging scrap under 3%—which is extremely good for such precision parts. Such improvements have reduced forging costs, although labor rates have risen.

The scale on the blade is removed in a wheelabrator after the hot blockdown operation. The blade is then reheated in an electric furnace and warm coined in a crank press. While still warm, flash is removed by trimming. The chordal width is now within a tolerance of $\pm$ 0.005 in., and other dimensions, such as form and thickness, are now less than $\pm$ 0.005 in. Fig. 2 shows the various steps in forging compressor blades: (a) slug of material, (b) extrusion, (c) blockdown, and (d) coin.

There are two projections on the centerline of gravity of the blade, one at the root and one at the

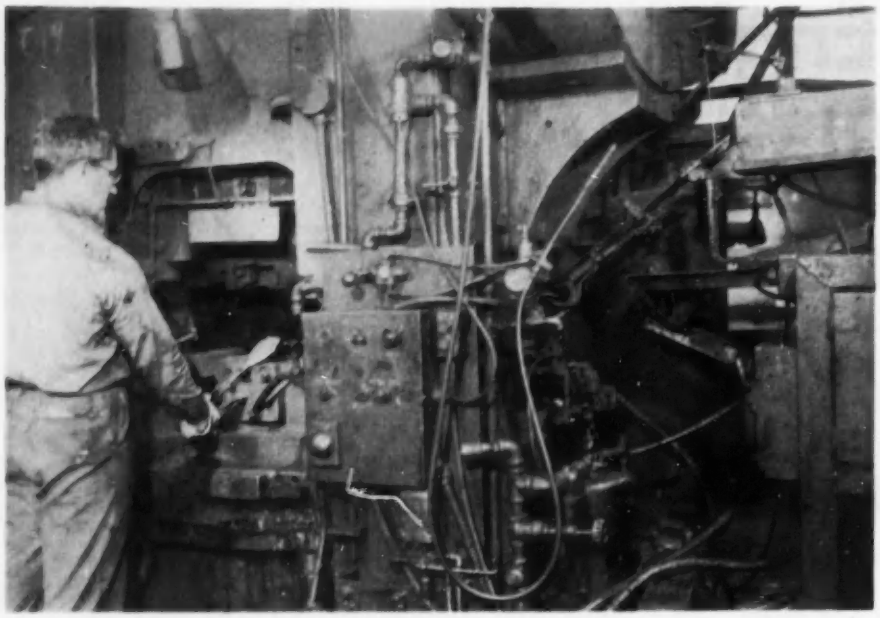


Fig. 1—Extrusion and block-down forging press

tip of the airfoil. These two projections are locating points for subsequent finishing operations, and are of tremendous value.

After coining, the blade is again blasted to remove scale. The end of the root is then broached, the blade being precisely located by the projections, and subsequent location at the root is made from these broached ends. Broaching the dovetail of the root then follows. These operations could also be done by grinding or milling. However, we favor broaching, and have developed automation in a continuous broaching machine (see Fig. 3), the operator simply feeding the parts into the machine. The angle end of the root is broached in one of these machines—production has been increased some 500% over conventional methods.

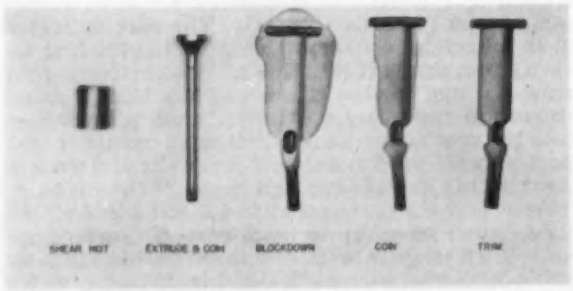


Fig. 2—Stages in forging compressor blades

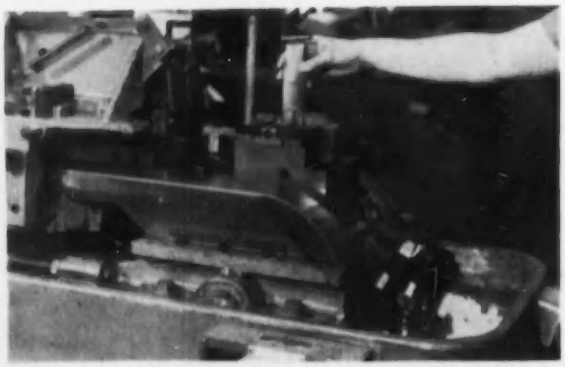


Fig. 3—Continuous broaching machine for compressor blades

After the root is finished, the leading and trailing edges are blended into the airfoil section on a specially developed automatic belt-type grinder (see Fig. 4). This machine evolved from the original method of hand blending through a changing series of special machines, since discarded in favor of the present equipment. The blending of the radii at the intersection of the airfoil and root is done on another machine, which produces a longitudinal polish, thus minimizing stress points.

Next, the only stock removal on the blade airfoil is done on the longitudinal polishing machine, which incorporates five oscillating heads arranged on a rotating turret, as shown in Fig. 5.

Fig. 6 shows an operator loading the machine from a central turret. The polished blade is ejected automatically. Three automatic changes of the abrasive polishing cloth are made during the rotation of the turret. The first rough polish removes a maximum of 0.0005 in. per side, followed by a final polish, removing a maximum of 0.00025 in. per side. Final finish is held to 16 microin. or better, and production rate is 900 blades per hr on this equipment.

Inspection of Blades—The guillotine gage (Fig. 7) is at present the most practical method of inspecting blades during the various stages of production. The forging is inspected for airfoil form and twist, and visually for surface imperfections. Hardness is checked after forging and heat-treating, and before machining. Magnaflux is used to inspect for surface defects, laps, and cracks after rough polish, prior to finish polishing. The machined root is inspected on indicator gages. Locating from the finished root, blade lean and leading edge relationship are checked

Fig. 4—Belt-type grinder for finishing leading and trailing edges of blade airfoil

with indicator gages, and in some cases on comparators. The twist is checked on a specially developed gage (Fig. 8).

Many expensive, slow, and cumbersome attempts have been made for the production checking of these and similar parts. To date, the guillotine gage has been the most practical and economical, but some recent developments are being used.

The red-line inspection method (Fig. 9) was developed by General Motors Research at the request of Allison. This a control check. A finished blade is placed in the machine and a red-line tracing is made of the airfoil contour at definite control points, enlarged 5, 10, or 20 times. The master outline on transparent material is then laid over this tracing for any given section. Deviations outside limits can be immediately noted and corrective action taken. Done at frequent intervals, this is a check on production inspection equipment.

A recent development is the Probograph, which can perform inspection at the rate of six to eight pieces per min, and can be used in the production line. This machine has had only limited use, and further experience will be needed for complete evaluation. Electric probes contact the blade contour, at which time a minute electric pulse passes through the probes. The probes are connected through an amplifier to styli, which move over a recording paper at a magnified ratio of the probes. A spark passes from the probes to the chart, forming a graph which shows the magnified dimensions of the part.

The well-known Sheffield air gage is also used in production for checking airfoils and roots on buckets.

Typical blade tolerances that might be specified by the engine designer, and must be held by the parts manufacturer, are:

Lean, in.	±0.017
Airfoil Thickness, in.	±0.005
Airfoil Width, in.	±0.005
Twist, min	±15
Finish, microin.	16 (or better)
Dimensions on Fastening End Held to, in.	±0.001

Rough Forging

Another production method is to forge oversize and then machine the airfoil and root to size. This method was believed necessary for some materials. Such forgings can be produced on presses or hammers, then heat-treated.

One method of machining the airfoil is to use a

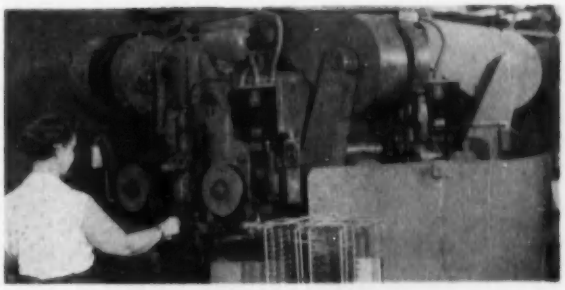


Fig. 5—Airfoil polishing machine

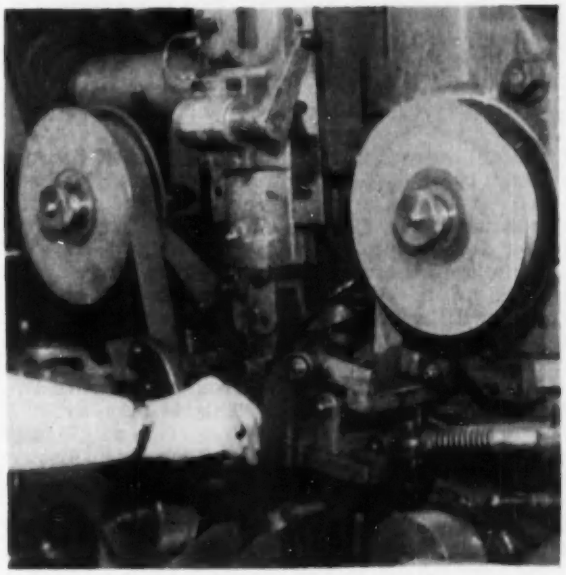


Fig. 6—Loading the airfoil polishing machine

Fig. 7—Guillotine gage for airfoil checking

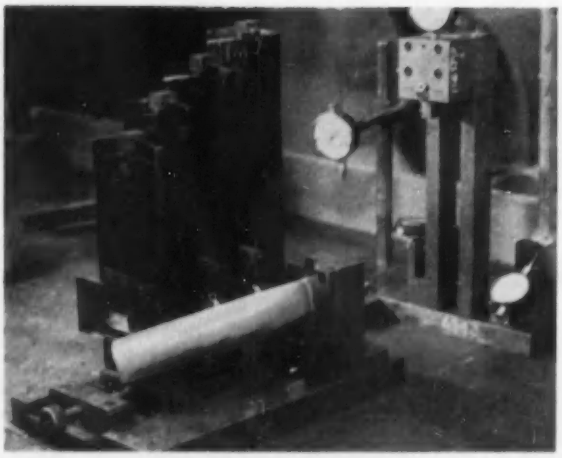


Fig. 8—Gage for checking airfoil twist

small milling cutter, machining one side of the airfoil at a time. Ball-nosed milling cutters have been used, as well as the fast-spiral method of removing excess material. These operations are tracer controlled from several cams.

Airfoils are ground after machining to get good surface finish. Simple airfoil sections can be controlled with a single cam, but where there is high twist and changing section, four cams may be needed.

Another method is to grind around the entire airfoil with an abrasive belt. This is done from a master, using three to four cams. This machine is a development of the Hamilton Standard Division of United Aircraft (see Fig. 10). After grinding, final finish is obtained by polishing the airfoil, leading and trailing edges, on abrasive belt grinders duplicating from a master. For blending fillets, a compound motion is used, which is actuated by another cam. The root is finished by broaching, milling, or grinding. Parts machined all over can be held to close tolerance, but the disadvantages are the time-consuming operations and the tremendous amount of equipment needed for war production.

If the forgings are shrouded, much more machining work is necessary.

Casting Processes

When parts are made of a nonforgeable material, the lost wax, lost plastic, or the frozen mercury process is usually used. Nozzle vanes and many turbine buckets are being cast by these methods.

A comparatively large grain size results. This large grain is considered advantageous from the standpoint of high-temperature creep, but it is undesirable for high alternating stresses produced by vibration.

The lost wax process is adequately covered in the literature. As applied to these turbine-engine parts, close tolerances and good surface finish are desirable, but internal soundness is *demanded*. The wax pattern flows slowly at room temperature, and a maximum interval is usually specified between the molding and investing of the pattern. The metal for casting is smelted in a small electric indirect arc or electric furnace containing only enough metal to pour one to six pieces, depending upon size. More pieces of very small parts can be made at one pour. Ordinarily, the mold at a temperature of 1200–2000 F is clamped to the furnace, and the two quickly inverted to allow the molten metal to run into the mold. In some cases gas pressure is applied to facilitate mold filling. Castings are usually given a stabilizing heat-treatment of about 50 hr. Castings of these turbine-engine parts are X-rayed for internal defects. In general the rejection rate due to surface defects, unsound castings, and distortion is high in this process. Best current practice *can* hold airfoil contour to ± 0.003 in., but average tolerances are greater to reduce the rate of rejection. It is not practical to cast trailing edges of 0.015 in. or less, and these edges are cast thicker and reduced to contour by polishing or grinding.

Plastics are sometimes used in place of wax as the pattern material. The advantages of polystyrene plastic patterns are: lower cost, good stability, and their handling properties are such that patterns can be inspected before investment.

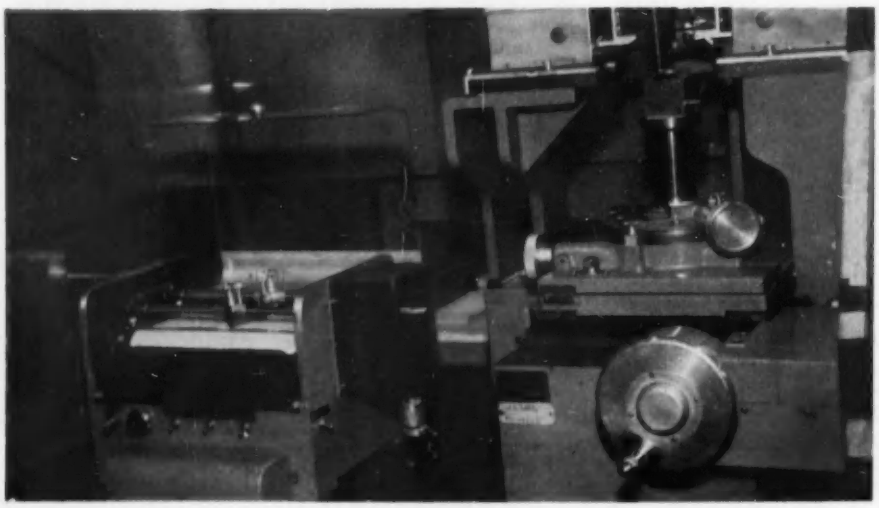


Fig. 9—Red line inspection machine

Costs are reduced (in large-volume production) since plastic patterns can be formed in a multicavity die injection mold. Where volume does not justify the fabrication of a multicavity mold, it is more economical to produce patterns by wax.

The stability of the plastic is good. Also, the plastic patterns can be handled, which permits inspection and gaging before investment.

Because solid-chills cannot be used, the shrinkage is greater in heavy sections of plastic patterns than in wax patterns.

This process uses frozen mercury instead of wax for patterns. Mercury freezes at – 40 F, and pattern work is performed at – 125 F, either by mechanical refrigeration or by using dry ice. Frozen mercury has the peculiar property of immediately making a strong weld when two pieces are brought in contact. This property makes possible the design and production of complicated assemblies as one piece, as the pattern can be built in simple sections and "welded" together. Hollow vanes and buckets with ribbed sections are entirely practical by the frozen mercury process, and other parts such as complicated wave guides and nozzle boxes.

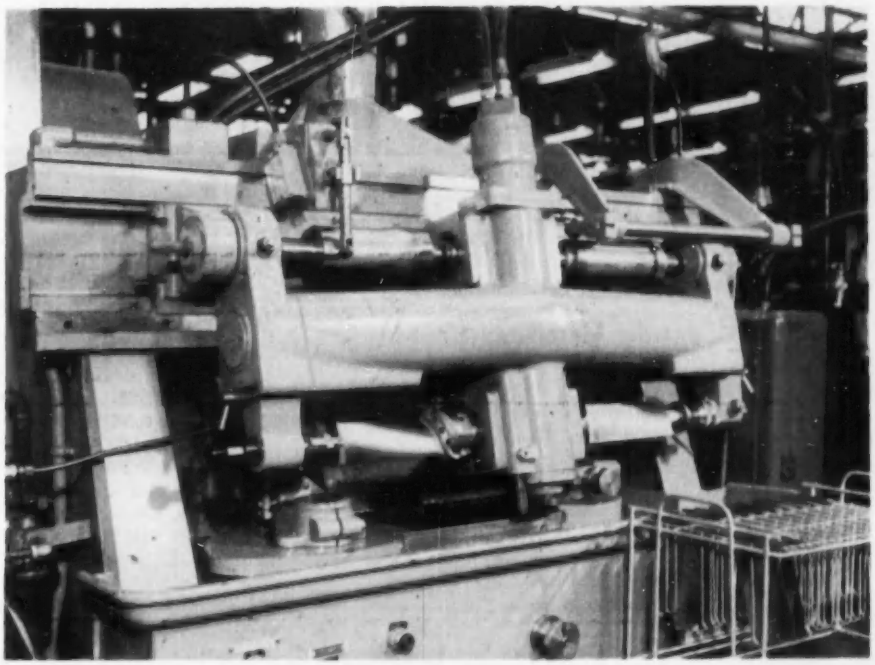


Fig. 10—Airfoil grinding machine

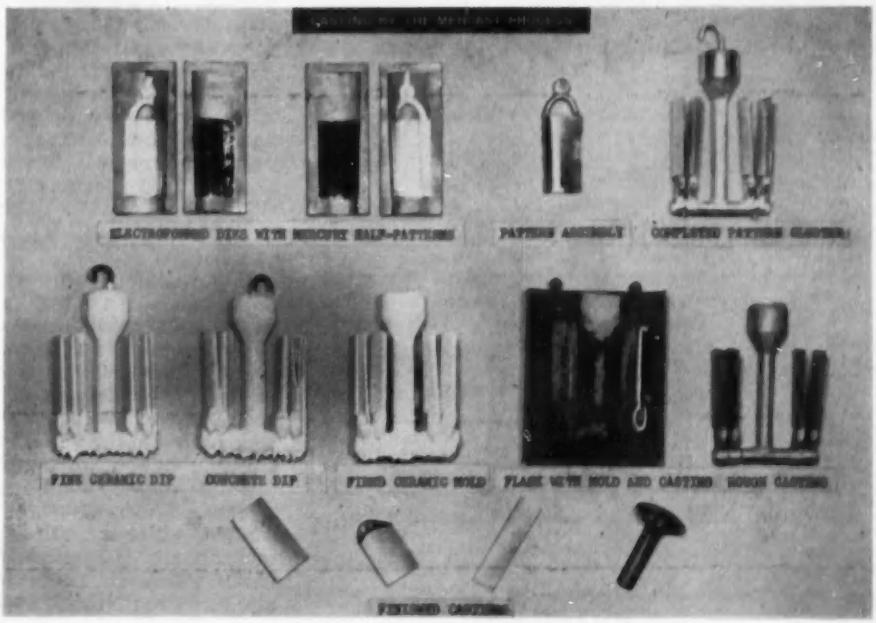


Fig. 11—Steps in making castings by Mercast process

The process is used for making castings having internal cavities so intricate that withdrawable cores cannot be used. Much larger parts can be made by this process than by lost wax—incidentally, this process is not called "lost mercury" because all the mercury is recovered when it is smelted from the pattern. The process gives better surface finish and closer tolerance than other investment processes, but the cost per se is higher—however, the yield is ordinarily much higher than with other processes, rejections being lower, so that on simple pieces it approaches competitive cost. For very intricate pieces it stands alone—hence the name "Intricast." Any castable alloy can be used with this process.

Mercury is poured into steel dies at – 125 F to make the pattern. This pattern is then invested with special ceramic slurries at subzero temperature, the initial dip being a very fine-grained ceramic to impart a smooth surface to the casting. The mercury is melted from the mold, which is then fired and set (the molds can be used for centrifugal castings). The molds are then filled with metal from high-frequency induction furnaces, making possible good control of metallurgy and analysis. Molds are then crushed to remove the castings. (See Fig. 11.)

Powder Metallurgy

We have made over 12,000,000 stator vanes by the sintered powder process (known as TP-1). They have performed exceptionally well. The process was developed when it appeared that the military program would demand 50,000,000 blades per month.

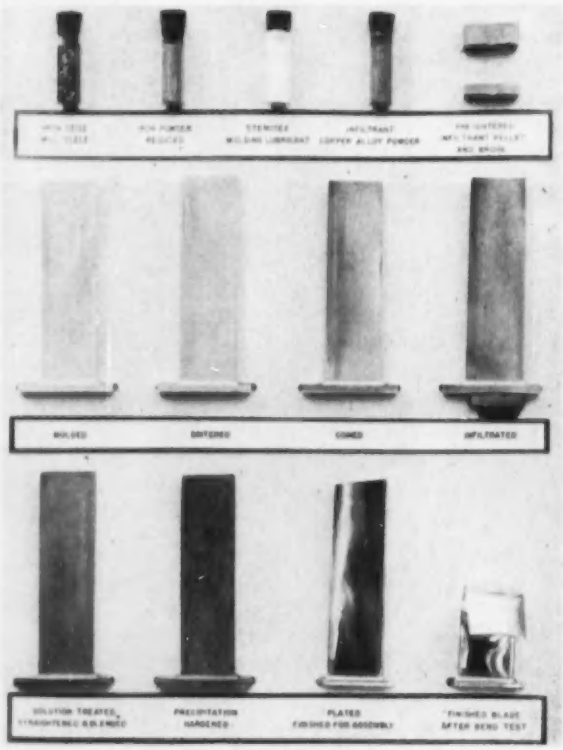


Fig. 12—TP-1 powder metallurgy process for manufacture of turbojet compressor blades

Use of the powder metallurgy process for the manufacturer of vanes helps conserve critical materials, eliminate the need for heavy forging equipment, and eliminate mill operations. TP-1 has been used only for vanes of comparatively small size. The blank can be machined or ground, and the sintered skeleton is made practically 100% dense by infiltration of a copper alloy. After heat-treatment, the blade has good physical properties and exceptional damping qualities, thus reducing stress.

In general the process resembles the making of buttered toast. The powder is compacted (the dough), sintered (baking), and then infiltrated (butter seeping into hot toast).

The various steps are shown in Fig. 12. The powder ingredients are mixed, blended, and sifted for the vanes, and also for the pellets and bridges used in infiltration.

The blade is molded in a 250-ton double-acting hydraulic press, the dies forming the blade contour. Experience has developed the correct amount of powder to be used, and proper die design, to achieve the desired porosity for infiltration. After molding, the vane has cohesive strength, but can be easily broken in one's fingers.

Sintering follows in a controlled atmosphere furnace (H or dissociated NH_3) at a temperature of 2000 F, well below the melting point of iron. This gives the blade appreciable strength.

Coining is done on a hydraulic press to compress the vane further, and to give twist and contour—strength is added, but there is still porosity.

The vane is then infiltrated with a copper alloy in a controlled atmosphere furnace at a temperature above the melting point of copper. The blade is held vertically, sintered iron and copper-alloy pellets are placed on the root, and by capillary action infiltration occurs to practically 100% density.

A solution heat-treatment is given, followed by an oil quench. A press straightening operation corrects any warpage that may have occurred. A precipitation hardening treatment provides the final strength properties for the TP-1 vane, with tensile strength over 110,000 psi, and ability to take a bend between 40 and 50 deg.

Edge blending, polishing, and broaching are similar to those described for blades. Finally, the vane is electroplated with 0.0005-in. nickel covered by a flash of chromium. This produces a good corrosion-resistant surface, and the blade uses some 12% less chrome than specified for stainless 403.

Fabrication

Hollow inlet guide vanes and stator and diaphragm vanes are also made by fabrication. Sheet metal is formed and the trailing edges are seam welded or heliarc or metallic arc welded (see Fig. 13). In some cases a solid trailing edge is welded to the vane, and is then machined to finish contour. In some designs strengthening ribs are brazed or spot welded inside the vane. Warm air can be circulated through hollow inlet guide vanes for de-icing.

Vanes of very thin material are best welded by heliarc. Those with greater thickness may be seam welded, while a trailing edge is usually joined by metallic arc. In the case of complicated inlet guide vanes where additions are made to each end, the metallic arc method is favored.

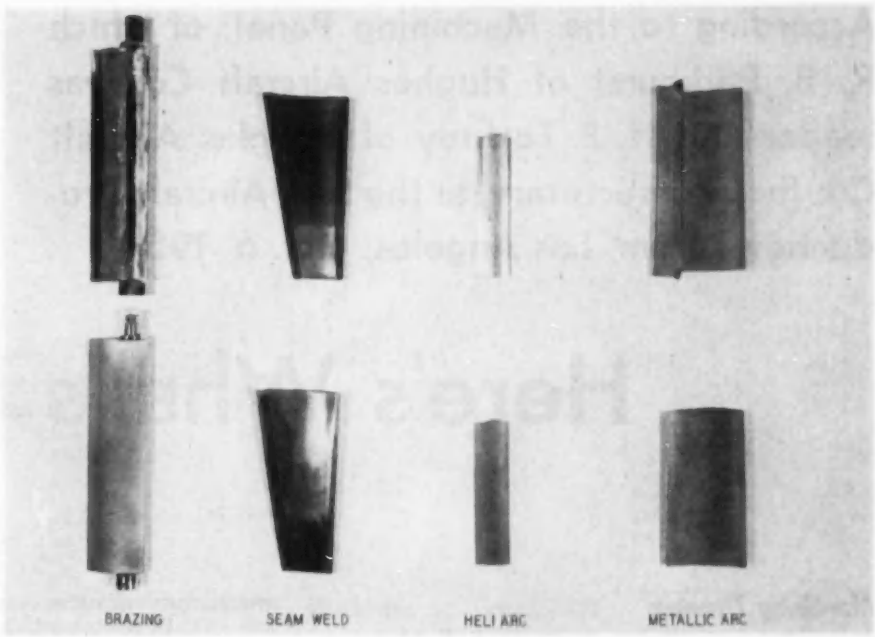


Fig. 13—Methods of fabricating vanes

Reinforced Plastic

Although the development of reinforced plastic blades is still on an experimental basis, the third stage of a compressor rotor was bladed with the fibrous glass-reinforced blades. This development originated with the idea of finding a fast and cheap method of making prototype blades. A 100-hr run at rated engine speed was successfully completed on the rotor. Inspection of the blades after disassembly from the rotor showed that they were in excellent condition. There were no signs of erosion or impending failure, and this test indicates continuation of the development (see Fig. 14).

Several properties of the plastic blade make it attractive. One consideration is that the fibrous glass-reinforced plastics are noncritical materials. Also, the plastic blade has a relatively high damping capacity, which keeps the stress low and the blade less susceptible to fatigue failure.

Another advantageous characteristic is the lightness. This blade property improves acceleration characteristics of the engine because of the resulting lower moment of inertia. Starting torque also is reduced.

The plastic material exhibits practically no creep, thereby minimizing chances of stress rupture. In spin pit tests at 110% overspeed for 15 min, there was no measurable creep on a 30-in. diameter installation (disc plus plastic blade). This compares with steel blades that grew 0.001–0.002 in. during the same type of test.

The plastic material's strength-to-weight ratio is about three times that for a compressor blade steel.

Relative to its mass, the plastic's impact strength is equal to that of compressor blade steel.

Disadvantages of the plastic blade are its nonisotropic strength properties. Also, the blade will be difficult to inspect adequately.

It is now possible to produce fibrous glass-reinforced plastic materials with the ability to withstand

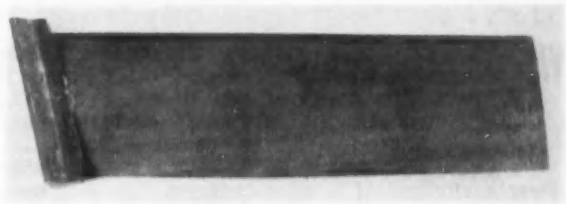


Fig. 14—Plastic blade

500 F. The blades in the 100-hr test ran at about 300 F; however, in the foreseeable future, phenolic-impregnated fibrous glass plastics may be able to withstand approximately 700 F for about 10 hr in a compressor blade application. This would indicate favorable progress in increasing the temperature limitation of the material.

The molding job for the compressor blade is more difficult than the usual procedure for forming reinforced plastics. Closer control is required in die design, of pressures, temperatures, and prelayup phases. Experimental results to date have been excellent—dimensional uniformity and fine surface finishes are obtained.

The molding process begins with the dry layup, which approximates the shape of the blade. The laminations, cut from phenolic-impregnated fibrous glass cloth, are held together mechanically.

The layup is placed in a male-and-female heated die arrangement in which it is subjected to a pressure forming cycle. When the molded part is removed it is about 90% complete. At this point, the blade is to size and shape. Dimensional control is excellent. A post-curing operation is then required for the resin in the blade to impart the necessary strength properties.

(Paper on which this abridgment is based is available in full in photo-offset form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

According to the Machining Panel, of which R. B. Parkhurst of Hughes Aircraft Co. was leader and H. E. Fortney of Douglas Aircraft Co., Inc. was secretary, at the SAE Aircraft Production Forum, Los Angeles, Oct. 6, 1954 . . .

Here's What's New in

Machining Titanium

E. F. Mellinger,
Ryan Aeronautical Co.

WE have come a long way along the road to understanding titanium's peculiarities.

We know, for example, that titanium deforms plastically less than half as much as low-carbon steel. This makes it easier to cut titanium.

We know also that titanium has a considerably lower coefficient of friction between chip and tool. This also is an advantage.

On the other hand, for the same speed and feed, the bearing area of the titanium chip against the tool is less than half that of steel. The smaller the bearing area, the greater the pressure and the more concentrated the frictional heat.

Titanium does not conduct the heat away readily, either. Cutting 150 surface ft per min with a 0.006 in. per revolution feed, the temperature on the bearing area of the titanium is 2250 F. For steel it would be 600 F.

Titanium's high temperature causes the tools to dissolve into the titanium chip. Titanium welds onto the tool, making it duller. This increases pressures, which in turn lead to more heat and more opportunity for welding.

It's easy to see, therefore, why coolants are so important in machining titanium. Convair has been very successful with aqueous solutions similar to U. S. Government Specification Type 4. The company has found these coolants suitable for drilling as well as for turning, grinding, and milling.

Other firms are using extreme-pressure water emulsion to minimize corrosion in their machinery. The CO_2 Development Co. has found that carbon dioxide keeps titanium cool enough during milling, drilling, and turning to prevent oxygen and nitrogen absorption. This leaves uncontaminated chips, which titanium producers believe might be salvable. Just as important, the carbon dioxide lessens the welding of titanium to the tools.

Other companies have experimented with carbon tetrachloride as a coolant. Results are good, but the toxic effect precludes use of carbon tetrachloride in production work.

Some firms have achieved good results on certain machining operations by milling the metal without using coolants.

Because pressure and heat are distributed over a large tool area when heavy feeds are used, they are superior to light feeds.

Tungsten carbide tools have proved the most effective kind for continuous cutting such as straight turning. But they chip during intermittent cutting. High-speed steel tools (with 7–8% cobalt) are the most satisfactory for interrupted cuts such as turning square stock. Whenever possible, intermittent cuts should be avoided.

Constant cutting speeds prevent the tool from riding on and glazing the metal's surface.

Pickling titanium removes scale formed during forging or hot rolling and thereby prolongs tool life. So does sharpening by the electric discharge method, which leaves the tool with a uniform 10-microin finish.

Machining Aluminum

W. E. Brainard,
Hughes Aircraft Co.

WE'VE come to the conclusion that for machining aluminum you need more horsepower and a much more rigid machine than for steel. The reason is that you can machine aluminum much faster.

On the other hand, the power requirements per

The report on which these briefs are based is available in full in multilith form together with reports of the nine other panel sessions of the 1954 SAE Aircraft Production Forum. This publication, SP-309, is available from the SAE Special Publications Department. Price: $2.00 to members; $4.00 to nonmembers.

Metal Cutting

cubic inch of aluminum removed per minute are about one-third that for mild steel.

If we can remove aluminum 10 or 15 times as fast, and aluminum requires one-third the power, simple arithmetic shows that we can use four or five times as much power to machine aluminum as we do to machine mild steel.

If we are to use that power effectively, we must have a much more rigid machine. And we must have a machine with much higher rates of feed than most we find on the market today.

Machining 280,000-PSI Steel

F. M. Rayburn,
Menasco Mfg. Co.

WE are machining SAE 4340 steel hardened to Rockwell C 53 to give 280,000 psi tensile strength in landing gear components.

To do it, we use the hardest, toughest grade of carbide tool we can get. The tool must be resistant to craters and edge wear. It must withstand nearly four times the pressure applied to the tool cutting 220,000-psi steel.

We need all the rigidity we can get in tooling. Because of the odd shapes and overhangs designed into landing gear parts, we can't always achieve really good rigidity, either in the fixture or the cutting tool and its holder. Frequently we compromise with regard to ideal speeds and feeds and depth of cut. Or we resort to unconventional cutting tool design. Ways, cross-slides, and gibs must, of course, be kept in perfect condition.

There are a few places where part shapes restrict surface cutting speeds so much that we use high-speed tool steel cutters instead of carbide cutters. M2 tool steel won't do the job, but M3 vanadium-molybdenum-tungsten tool steel will.

We fortify all high-speed tools with a special chrome-flashing, not the conventional hard chrome. Its greatest virtues are probably its lubricity and its ability to prevent smearing and build-up.

Machining at High Speeds

J. C. Herbert and Leif Fersing,
Jones & Lamson Machine Co.

HIGHER-than-conventional cutting speeds give better finishes and save money.

In planning the machining of a steel part in the annealed state, it's wise to start at 500–600 surface fpm and then try higher speeds to see if speed increases will pay. High speeds and corresponding lower tool loads permit use of even the hardest grades of carbide tools because there is less welding and freer chip flow at the lower loads.

High cutting speeds and reduced tool loads also create less disturbance of the surface structure of the work piece and leave a better surface finish. Furthermore, there is less variation in size from part to part.

All this points to the advantages of pushing cutting speeds higher, in continuation of the trend started back in 1870. In that year, Robert Mushet added small amounts of tungsten and manganese to carbon steel and found that cutting tools made from the alloyed steel could boost cutting speeds from the prevalent 16 fpm to 26 fpm. Later, about

Continued on page 74

Controlling Tools Electrically

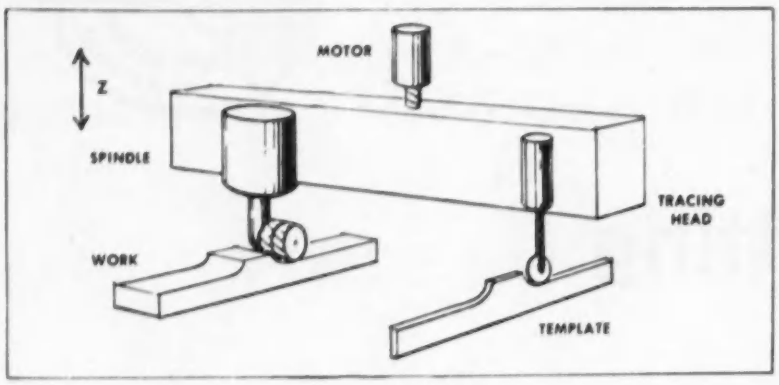
C. M. Rhoades, Jr.,
General Electric Co.

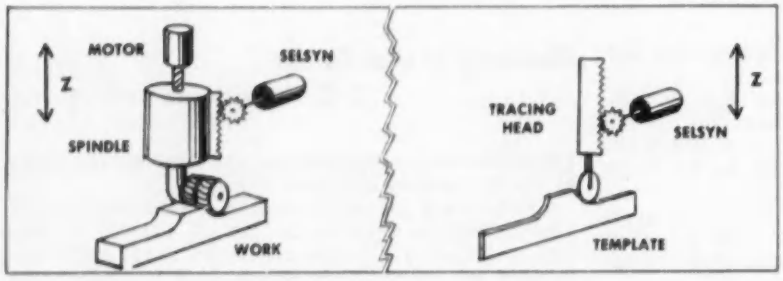
ELECTRIC controls are making machine tools more automatic. Various electrical units can sense and control position, speed, and load. They can be put to work on single machines, or—combined with automatic materials handling equipment in an

integrated system—they can serve the automated factory.

The information by which the electric device controls the machine tool may be stored via templates or limit switches or on magnetic tape.

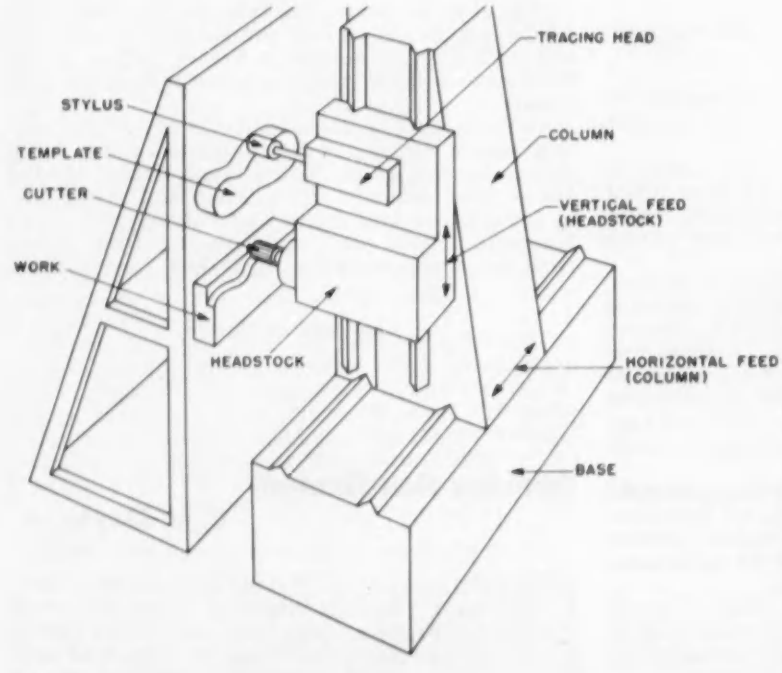
Tracer controls following templates are simple and already widely used. But there are many more applications where they would pay their way. The illustrations which follow suggest what they can do.





SINGLE-DIMENSION tracer control governs one feed motion from a template. The other motion of the machine is controlled independently by the operator. Arrangement is used to raise and lower skin mills, among other tools.

Single-dimension tracers depend on change in relative displacement of the tracing stylus with respect to the tool to obtain feed speed changes to produce a different slope on the work. This displacement along the axis of feed motion results in an error, usually varying directly with feed speed. But, if the error is significant, it can be compensated for, in the template.



TWO-DIMENSION tracing head controls two motions of the machine for profiling work. The signals can be combined electronically to provide for constant feed speed of the cutter past the work, regardless of direction.

There are no velocity errors, since the system operates with a constant deflection of the tracing head.

Feed speed is set via a rheostat on the operator's panel.

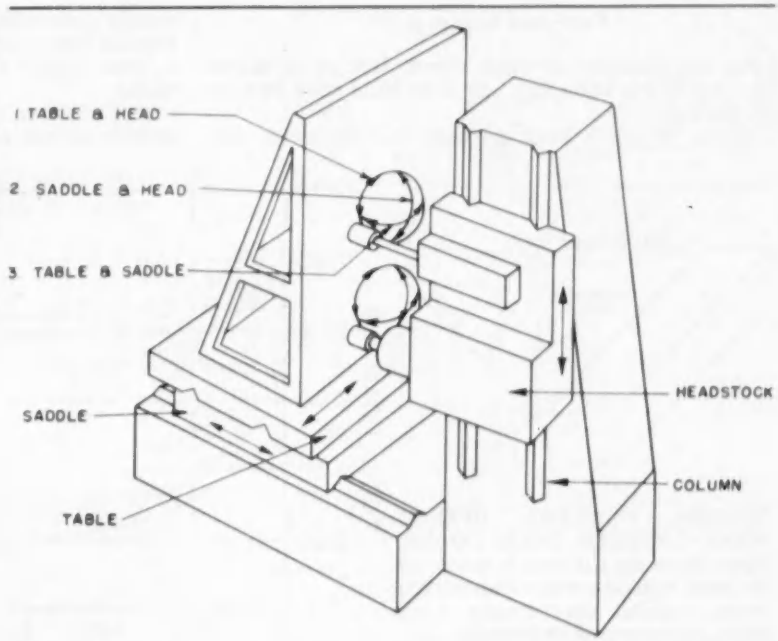
Electronic equipment provides correct control power for the fields of the amplidyne generator supplying power to the feed motors.

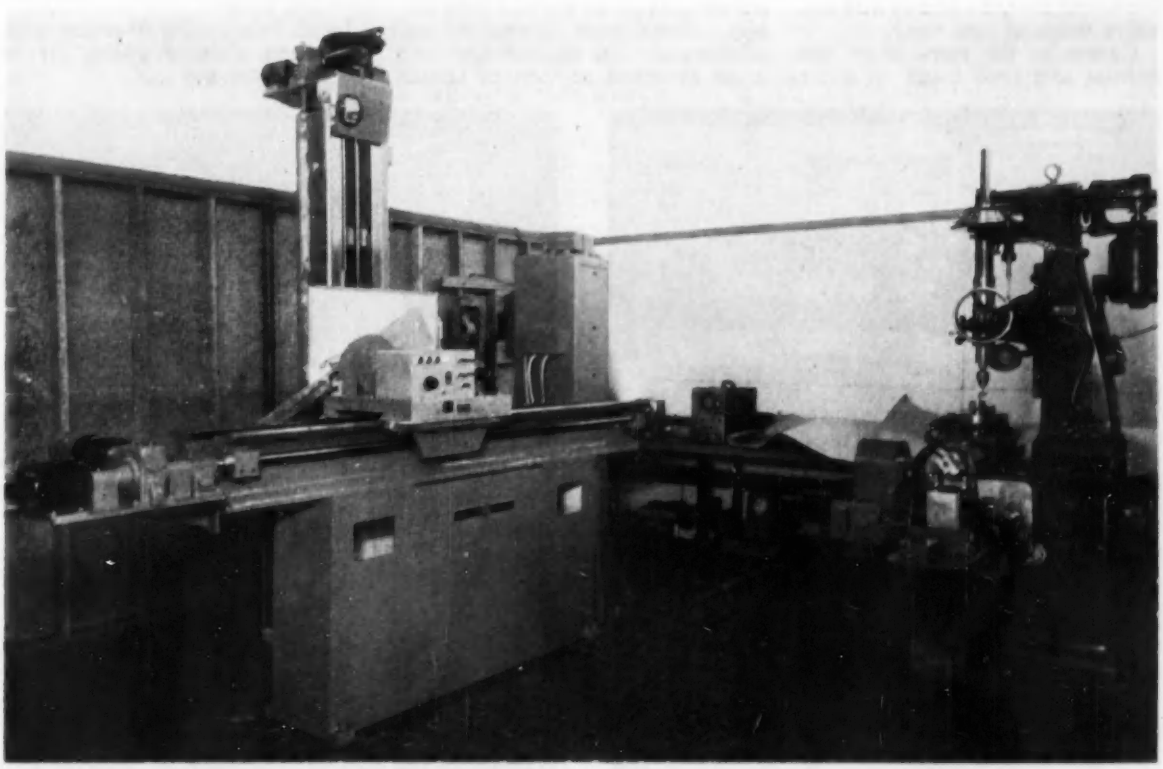
Two-dimensional tracers like this have been applied to vertical boring mills, small milling machines, and big skin mills.

SELECTIVE TWO - DIMENSION tracer controls any two of three dimensions simultaneously from a single tracing head.

System is similar to regular two-dimension tracing arrangement, except for tracing head. This must be responsive to motion in three coordinates. Therefore it is more complex mechanically than the two-dimension head.

Typical of the applications for the selective two-dimension tracer is a planer-type horizontal boring mill.





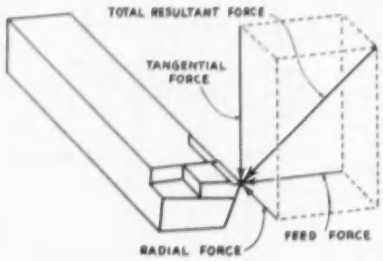
PHOTOELECTRIC TRACING head controls a tool to follow a line on a drawing. Shown here is a machine used to make masters for aircraft turbine-engine blades. Light-sensitive line follower drives selsyn generators powering selsyn motors governing the motions of the small milling machine. To provide very accurate results, drawings can be made to a large scale and reduction in size made through the gearing. Photoelectric tracing is particularly useful for making templates.

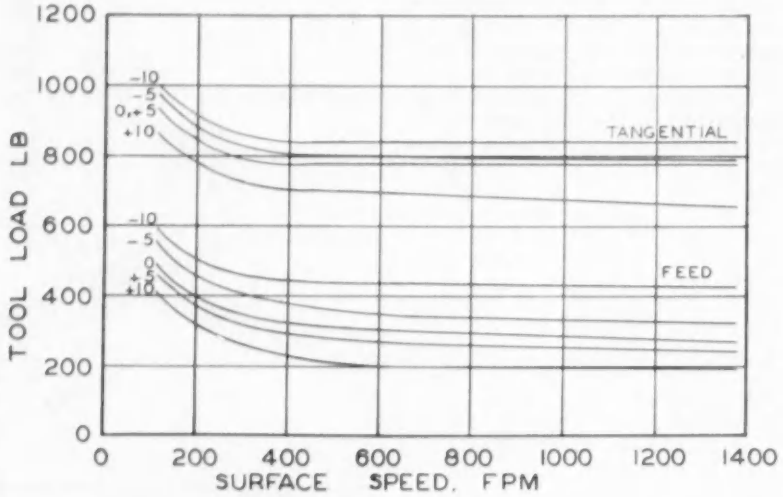
Continued from page 71

1900, introduction of "high speed" tool steels raised cutting speeds to 60 fpm. By 1906, mild steel was cut at 100 fpm.

Then 30 years later carbide cutting steels appeared and cutting speeds took another leap to the 250–350 fpm range. Many shops still machine mostly in this range, although some turn at 500 fpm or faster.

The pictures which follow show why still higher cutting speeds are advantageous.

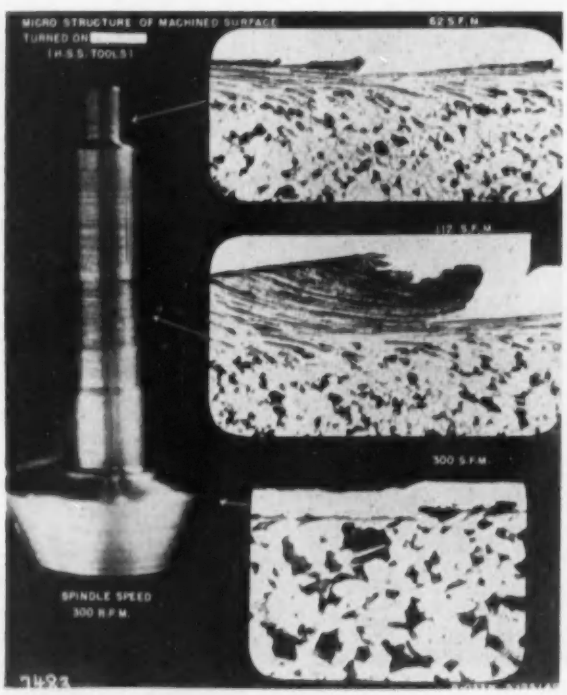


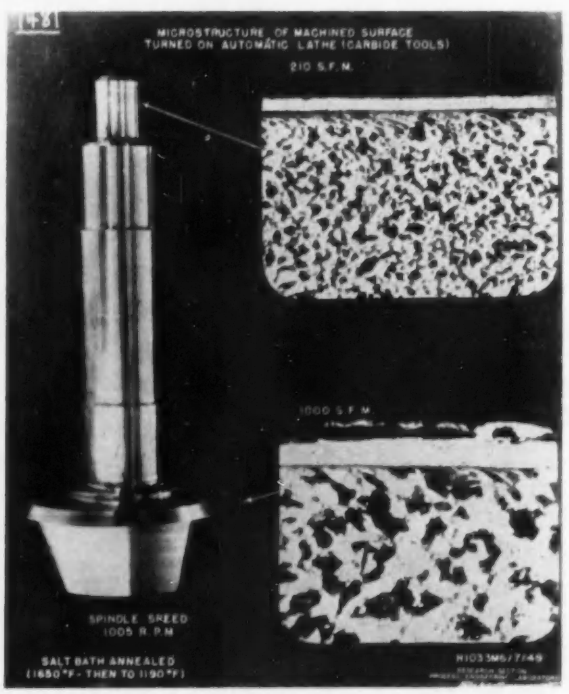


HIGHER CUTTING SPEEDS MEAN LIGHTER TOOL LOADS. Total force on the tool is made up of three components. Tangential force, applied via turning work piece, increases only slightly during useful life of tool. But feed force and radial force, the other two forces, increase as tool wears. Feed load makes a handy and sensitive index of tool wear.

Curves at the right show tangential and feed loads on a tool turning 8749 steel at 0.011 in. feed per revolution at various rake angles. Tests were started at approximately 125 surface fpm and loads recorded at various speeds up to 1400 fpm, using sharp tools for each speed.

Loads beneficially decrease with increasing cutting speed up to speeds of 400–600 fpm.





HIGHER CUTTING SPEEDS LEAVE BETTER SURFACE FINISH. Pinion gear at the left was turned with high-speed steel cutting tools, using multiple tooling, at a cutting speed of approximately 62 surface fpm on the thread diameter.

Better finish on pinion at the right results from turning it at the much faster cutting speeds used with carbide tools.

Mr. Adams Goes to Cincinnati

MR. ADAMS CHECKED IN at the hotel the night before the start of the three-day Meeting after flying in from Cleveland

NEARLY 400 engineers and manufacturing men attended the three-day SAE Golden Anniversary Production Meeting in Cincinnati, March 14–16.

Typical of these engineers who attended the Production Forum panels, sat in on the technical sessions, and visited the General Electric and Cincinnati Milling Machine plants was Joseph E. Adams, director of planning and purchasing, White Motor Co.

SAE Journal brings you the story of this Meeting through the eyes of this production executive. The Journal camera recorded highlights of Adams' activities in Cincinnati. And a Journal reporter (JR below) interviewed Adams for his reactions to the information that came out of the Meeting.

Adams' interest in all of the manufacturing and management problems at the Meetings grows out of his wide responsibilities at White Motor. His bailiwick encompasses procurement, scheduling, inventory control, traffic, materials handling, and production control.

JR (JOURNAL REPORTER): Mr. Adams, what did you get out of this Meeting?

ADAMS: I got lots of specific ideas and fresh information. And I'd like to tell you about those. But there are several important general values I get from an SAE meeting, such as this one.

JR: What are they?

ADAMS: First, you can pick up information in a relaxed way, which can't be done back at the plant. You get these ideas from old friends. And in getting ideas, you also make new friends. This sort of thing keeps me from becoming inbred and introverted. Often a problem at the plant seems insurmountable. I go to a meeting, get some ideas, and suddenly the solution to my problem becomes clear.

JR: Is there anything else you get out of a meeting of this kind?

ADAMS: Yes. I get a yardstick on my own

AN EARLY START on the first morning comes by way of a rude awakening at 7:00 a.m. to get to an 8:00 a.m. meeting

PRODUCTION FORUM OFFICIALS B. W. Mahoney (left), chairman, and K. W. Stalker (right), co-chairman, are joined by Adams in looking over arrangements before the Forum gets under way

SIGNING IN at the SAE registration desk officially launches the Meeting for Adams and the hundreds of others who came to Cincinnati

PANEL MEMBER ADAMS participated actively on the Production and Material Control Panel. He contributed ideas and took away some too. Said Adams: "Guess I learned at least as much from the discussions during the panel session as the fellows in the audience." He has served on several SAE Production Forums in other cities, and is helping to plan and develop one in Cleveland, to be held next year

performance in relation to others. It's a means of self-appraisal. I guess I enjoy getting into discussions at panels and technical sessions. I suppose it makes everybody feel good to help others by offering ideas born of his own experiences.

JR: What particular problem did the Meeting point up to you as important? Most important for production engineers?

ADAMS: I'd say communications. Behind every technical production problem discussed here lies this major obstacle . . . the transmission of ideas from one mind to another . . . from management to the production engineer, from design engineers to shop men, from customers to vendors.

JR: Can you be more specific?

ADAMS: Yes. Kelley and Buckmaster, for instance, made the point in their paper on automation. In too many cases managements are rushing into automation because they have failed to get themselves informed on all its implications and its real costs. Automation calls for management reappraisal of interdepartmental operations. It will have to learn a lot more about the details of its business.

Management also will have to consider its suppliers. A change in product design may obsolete the vendor's heavy investment in automatic machinery, throwing him for a heavy financial loss. . . . So the vendor has to be kept informed to permit intelligent, economical equipment planning in his plant.

JR: Did you find other evidence of this lack of communication at the Meeting?

ADAMS: Yes. The panel on "Coordination between Engineering and Manufacturing" spent a whole day on the subject. There, people kept emphasizing this situation in companies of all sizes. They showed that today's industrial inefficiency stems from management, manufacturing, and engineering not fully understanding each other's functions and their relationship to the whole.

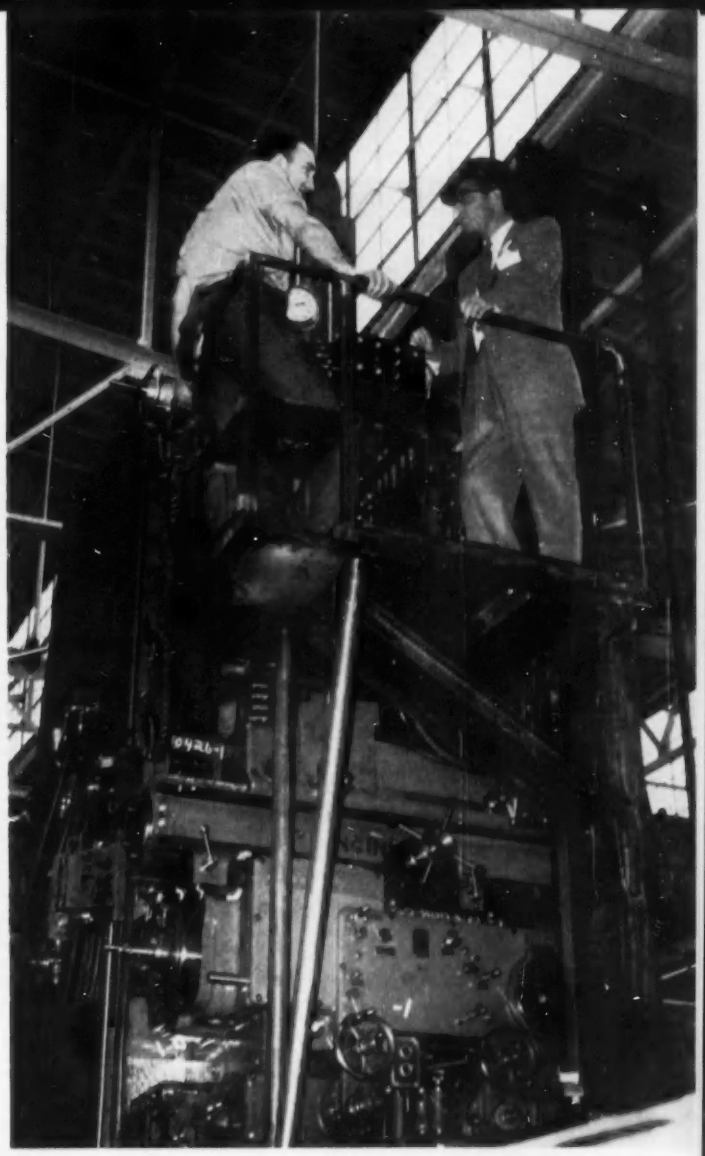
JR: Why has communication become so ineffective?

ADAMS: At least as regards management, too many other factors are taking a preponderance of its time . . . government, labor, and legal problems. Management people no longer have as much time to run their business as in the past.

JR: What's the answer?

ADAMS: I'd guess we will have to develop larger management teams. Management itself will probably have to become more departmentalized. Management must develop a middleground to attack the many ramifications that have entered the industrial scene.

At the same time, it must recapture the warmth that was the driving force and inspiration of prewar management production teams.



PLANT INSPECTION at Cincinnati Milling Machine got Adams interested in machine tools being built there. He climbed Hydrotel under construction to ask assembler about machine's operation and its destination.

JR: How does communications tie in with other production functions?

ADAMS: Well, quality control is another case in point. Discussion at the QC panel proved that. QC is just a good communication method of doing business with various manufacturing departments within your plant and with outside vendors. It has been a catchword for a concept (as is automation).

QC is merely a way of reducing to a chart all available information. People are beginning to use it on a down-to-earth basis. They've stopped looking on it as a cure-all.

JR: Does that imply that you see limitations to QC application?

PRE-DINNER CHAT with Meeting Sponsor and Toastmaster S. E. Bergstrom (left) and SAE Cincinnati Section Chairman P. C. Drees acquaints Adams with local manufacturing problems

CLEVELAND CRONY E. F. Gibian whiles away several evening hours with Adams. "Seems as though we see more of each other at SAE meetings out of town than we do at home," Adams remarked to Gibian. Both have made a number of trips to Europe and enjoy swapping travel experiences

DINNER TALK PREVIEW is given by dinner speaker George Hill, vice-president of Curtiss-Wright Corp., to Adams

SAE PRESIDENT ROSEN and Adams agree that the need for creativity is as much of a challenge to manufacturing men as to design engineers and researchers

ADAMS: Yes. As discussers at the panel session showed, you're still up against the human element, no matter how elaborate your QC program. The man at the machine is still the factor that determines quality of the product. Even with automation, management shouldn't expect the machine to assume full responsibility for quality. You just can't replace human judgment with a machine.

JR: What are you driving at?

ADAMS: Simply this. In addition to maintaining a QC system, production management must communicate to the man on the machine the importance of his job. That's part of management's training responsibility.

JR: Is this being done effectively today?

ADAMS: Sure, but not in enough places. One company that seems to be making it pay off is Cincinnati Milling Machine.

On my visit to the plant during the Meeting, I was particularly impressed by several things. The men building machine tools there had a pride in their work. They were eager to tell me what the product was, who it was being made for, and what kind of work it was to be used on. What's more, the plant is one of the cleanest and most orderly I have ever been privileged to visit. That's a reflection of pride of workmanship and a feeling of responsibility assumed by the shop force. It was probably inspired by intelligent management operations.

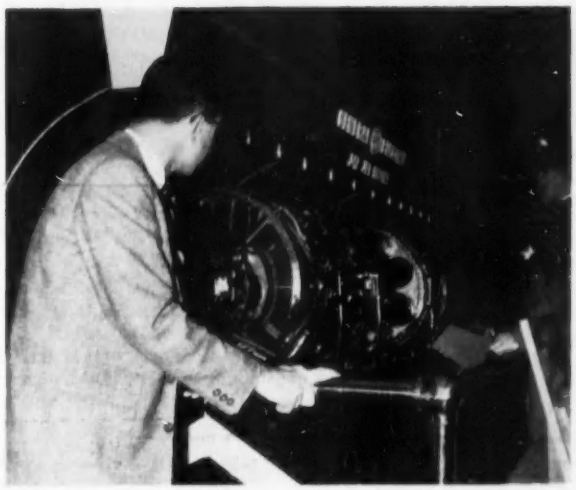
JR: Materials management was another aspect of the manufacturing function discussed at this Meeting. Did you note any trends in this area that have any significance?

ADAMS: I was interested to hear that we're learning to squeeze better performance out of carbon and low-alloy steels. By processes such as flame hardening and shotpeening, properties of these steels are being made comparable to those of higher alloy materials.

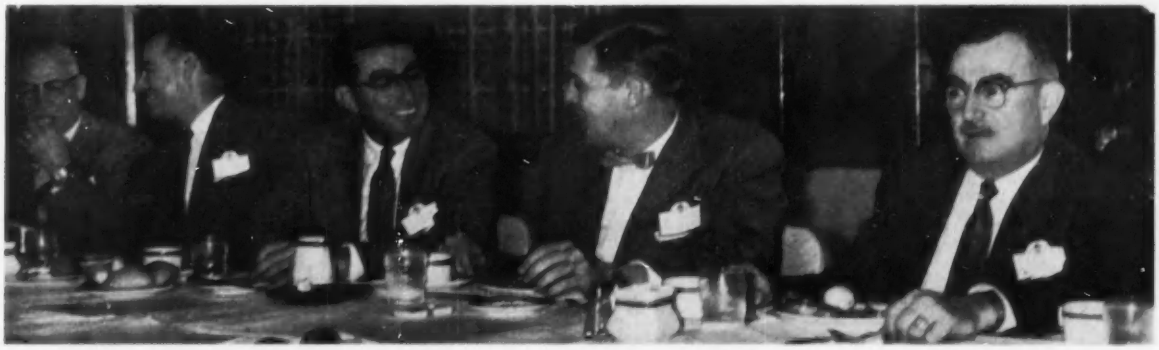
JR: In his paper on materials management, Gurski showed how automotive companies could save many dollars by standardization and simplification of materials. Do you feel that this program which Ford has instituted has application in other, perhaps smaller, companies?

ADAMS: There are few companies that couldn't profit from this kind of thinking. Gurski pointed up very effectively the old engineering adage that "what's good enough is best."

All too often, today, engineering departments are overly rigid in the materials they specify. In some cases it grows from lack of knowledge of what happens to a part in service. For this kind of ignorance we may be forced to pay a high insurance premium in materials that are too good for what we need.



JET ENGINE INTRIGUES Adams, since it might someday power the trucks his company builds. He later saw engines like this J47 manufactured at General Electric's Evendale plant



MANUFACTURING PROBLEMS got a thorough going-over at the meeting of the Production Activity Committee, led by SAE Vice-President P. A. Miller (second from right) and Meetings Vice-Chairman E. O. Wirth (right). Committee member Adams shared concern with his colleagues over the problems of automation. He came away with a subcommittee assignment to help throw light on the problems

John S. Behne, General Chairman of Meeting

JR: Then I take it that you feel many dollars can be saved in judicious purchasing of materials?

ADAMS: There are sizable potential savings in purchasing manufactured components as well as materials. Remember that products of most automotive companies consist of parts and materials, 50 to 85% of which have been purchased from outside sources.

JR: Since purchasing seems to be more important than is generally realized, what would you suggest as an engineering approach to the purchasing function?

ADAMS: For one, don't buy on price alone. Call on vendors, check their facilities, the delivery experience of other customers with the prospective vendor. Have your materials handling engineer approve the palletizing, since it's possible to save money here, too. It's most important to have technically trained people in purchasing. The purchasing agent must understand the function and performance of the part he is buying as well as its quality.

JR: At the panel discussions, forecasting was said to be the source of much concern in production planning. What are some of the implications of this?

ADAMS: Sales departments in companies of all sizes are unable to anticipate requirements successfully, even where elaborate market studies are made. So materials inventory and production control must be adjusted to changing needs.

Today's poor forecasting is an outgrowth of the postwar era, when consumer demand was great enough for excessive costs to be absorbed by high selling prices. In today's competitive market, a manufacturer cannot tolerate the excessive costs that come from schedule dislocations growing out of poor forecasting.

JR: What other features of this Meeting did you find helpful?

ADAMS: I found it particularly reassuring to meet with the SAE Production Activity Committee. Here is a group of men who are leaders in industry, who, despite individual company loyalties, are working together objectively on the solution of industry problems.

Even though their individual companies are engaged in serious sales competition, these men are laying aside these considerations. They are working together toward common industry objectives . . . throwing light on the problems of automation, production-design communications, and new manufacturing methods.

Among Those Who Participated in the Meeting . . .

Production Forum Panels

- Machine Tools in Automation
  Panel Leader: P. H. Alspach,
  General Electric Co.
- Chipless Production
  Panel Leader: R. L. Kessler,
  Delco Remy Division, GMC
- Selection of Material as it Affects Production Cost
  Panel Leader: F. C. Smith,
  Tube Turns Division, National Cylinder Gas Co.
- Quality Control—An Instrument for Better Management Decisions
  Panel Leader: Leon Bass,
  General Electric Co.
- Coordination Between Engineering and Manufacturing
  Panel Leader: A. H. Dall,
  Cincinnati Milling Machine Co.
- Controlled Economical Tooling and Shop Methods
  Panel Leader: Glenn Periman,
  North American Aviation, Inc.
- Analysis and Control of Manufacturing Costs
  Panel Leader: E. O. Wirth,
  Bendix Products Division, Bendix Aviation Corp.
- Production and Material Control
  Panel Leader: F. C. McCoard,
  Ford Motor Co.

Authors of Papers

"Urgent Need for Basic Principles of Automation," by **E. H. Kelley** and **J. T. Buckmaster,**
Chevrolet Motor Division, GMC

"Materials Management," by **Joseph Gurski,**
Ford Motor Co.

"A Sound Approach to Good Tool Life," by **S. R. Prance,**
Inland Mfg. Division, GMC

1955 SAE Golden Anniversary Summer Meeting

June 12-17, 1955 Chalfonte-Haddon Hall Hotels Atlantic City, N. J.

★ SPECIAL EVENT

Horning Memorial Lecture to be given by the famous British automotive engineer, Sir Harry Ricardo. He will talk of "Some Early Reminiscences."

TECHNICAL SESSIONS

will bring you up-to-date information on

- Stability of jet aircraft fuels
- Steels treated for 1000 F use
- Fiberglas-reinforced plastics
- New automatic transmission friction materials

ROUND TABLE DISCUSSIONS

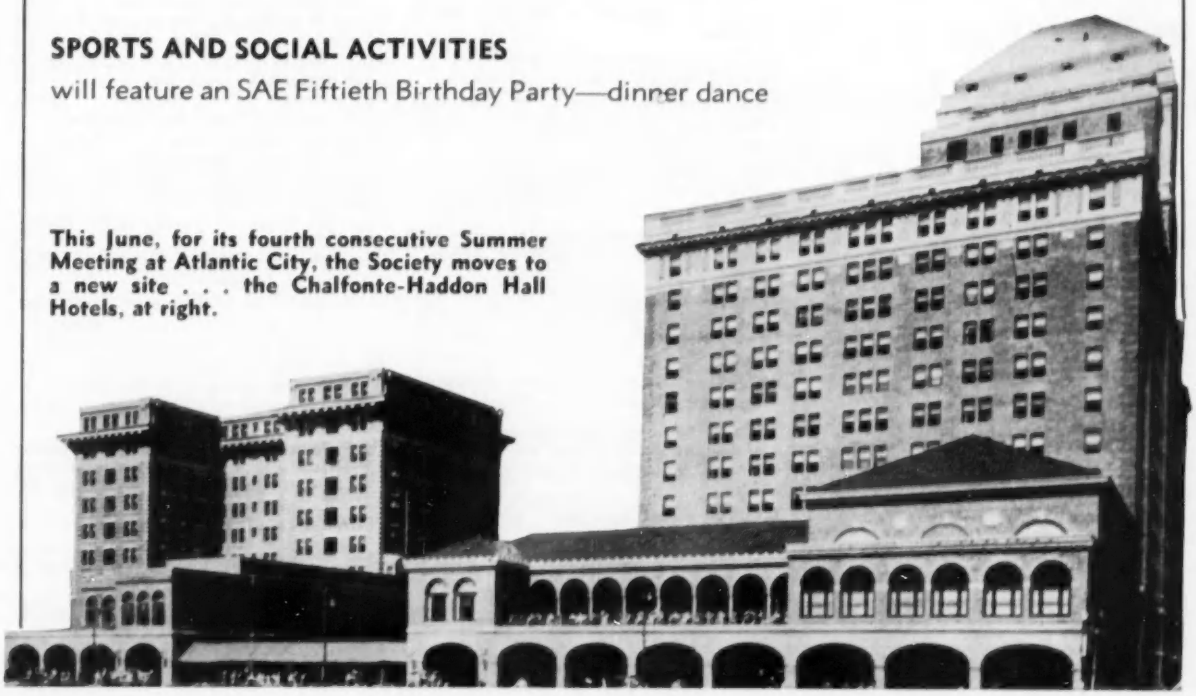
will explore currently important phases of

- Burning heavy diesel fuels
- Smog and noise reduction
- Manufacturing research programs
- Power train compatibility

SPORTS AND SOCIAL ACTIVITIES

will feature an SAE Fiftieth Birthday Party—dinner dance

This June, for its fourth consecutive Summer Meeting at Atlantic City, the Society moves to a new site . . . the Chalfonte-Haddon Hall Hotels, at right.



63 Papers Approved So Far for 1955 SAE Transactions

THE 1955 SAE Transactions is scheduled for publication early in August. It will contain about 700 pages, and will be cloth bound. It will include an author, title, and subject index covering all papers and their discussions contained in the volume.

So far, 63 papers have been approved by SAE Readers Committees for inclusion in this Transactions. Each of these papers will be printed in full, complete with written discussions of the papers. In some cases, the secretary's report of the oral discussion that took place after the presentation of the main paper is included.

Prices are: $3 to members, $7 to public and college libraries and U. S. Government agencies, $10 to nonmembers; foreign: $3 to members, $8 to public and college libraries, $11 to nonmembers.

The papers approved so far are:

Wear, Scuffing, and Spalling in Passenger-Car Engines—by H. A. Ambrose and J. E. Taylor

Antiknock Requirements of Passenger Cars—1953 CRC Survey—by H. W. Best, H. A. Bigley, and R. K. Williams

Lifters and Lubricants—by J. B. Bidwell and Paul Vermaire

New Look in Lubricating Oils—by J. B. Bidwell and R. K. Williams

Jet Engine Blading—Materials and Techniques of Fabrication—by A. T. Colwell

Comparison of the Intermediate-Combustion Products Formed in an Engine With and Without Ignition—by W. C. Davis, M. L. Smith, E. W. Malmberg, and J. Bobbitt

Carburetor Icing Tendencies of Some Present-Day Fuels and Engines—by W. P. Dugan and H. A. Toulmin

APF—What It is and What It Does—by W. L. Faith

Acoustic Design and Performance of Turbojet Test Facilities—by R. O. Fehr and B. E. Crocker

Airplane Manufacturer's Progress with Noise Suppression Devices—by R. E. I. Fogle and H. W. Withington

Some Factors Affecting the Fatigue Strength of Steel Members—by C. W. Gadd, J. O. Anderson, and David Martin

Design, Evaluation, and Selection of Heavy-Duty Rear Axles—by K. W. Gordon

Buick's Twin Turbine Dynaflow Transmission—by R. J. Gorsky

Tractor Seat Suspensions for Easy Riding—by Max Haack

Automobile Exhaust and Ozone Formation—by A. J. Haagen-Smit and Margaret M. Fox

Practical Yardsticks for Deposit Effects—by C. A. Hall, J. A. Warren, and J. D. McCullough

Development of a New Gas Turbine Super Alloy GMR-235—by D. K. Hanink, F. J. Webbere, and A. L. Boeghold

Influence of Lubricant and Material Variables on Cam and Tappett Surface Distress—by T. W. Havely, C. A. Phalen, and D. G. Bunnell

Coordination of Electric with Other Braking Systems—by F. C. Hile

Flight Load Measurements and Analysis—by W. L. Howland and C. J. Buzzetti

Inventory of Automobile Exhaust Gases—by D. H. Hutchison and F. R. Holden

Simulated Jet Transport Operation—by R. D. Kelly and H. B. Kaster

Fuel Properties and Jet-Engine Combustor Performance—by C. M. Kuhbach, W. F. Ritcheske, and K. H. Strauss

Study of Distribution and Effects of Automotive Exhaust Gases in Los Angeles—by Gordon P. Larson, John C. Chipman, and Erwin K. Kauper

New Pontiac V-8 Engine—by C. B. Leach and E. L. Windeler

Effects of Operational Factors on Structural Fatigue in Fighter-Type Aircraft—by G. N. Mangurian and P. D. Brooks

Symposium—Plastics for Truck Bodies—The Picture in Detail—by H. McCann, D. S. Brown, S. Wulc, W. R. Herfurth, and H. Jennings

Who Is the Designer—The Stylist or the Engineer?—by D. McRae and K. E. Coppock

Correlation of Engine Noises with Combustion Phenomena—by R. Meagher, R. L. Johnson, and K. G. Parthemore

Engine Cranking at Arctic Temperatures—by W. E. Meyer, J. J. DeCarolis, and R. L. Stanley

Tractor-Engine Design Requirements for Best Fuel Utilization—by H. T. Mueller and R. E. Gish

Temperature Limitations of Petroleum Synthetic and Other Lubricants in Rolling Contact Bearings—by Z. N. Nemeth and W. J. Anderson

Weighing Vehicles Static and in Motion by Electronic Scales—by O. K. Normann

Effect of Surface Temperature on the Wear of Diesel-Engine Cylinders and Piston Rings—by H. V. Nutt, E. W. Landen, and J. A. Edgar

When Are Brakes "Adequate?"—by J. G. Oetzel

High Supercharging Development of a GM 16-278A Two-Stroke-Cycle Diesel Engine—by W. G. Payne, and Wolfgang S. Lang

Method of Scavenging Analysis for 2-Stroke-Cycle Diesel Cylinders—by W. H. Percival

Improvement in Stopping Aibility of Motor Trucks in Use on the Highway—by F. W. Petring

Basic Facts about Noise as Related to Aviation—by A. C. Pietrasanta and R. H. Bolt

Size, Structure, and Shape of European Automobiles—by L. Pomeroy

Application of Airborne Radar to Airline Operations—by E. A. Post

Designing New Performance into a Special Motor Oil—by L. Raymond and J. F. Socolofsky

Why Do Airplanes Make Noise—by A. A. Regier

Report on Reserve Tractive Ability and Vehicle Drag Test Codes and Comparative Demonstration of Test Equipment—by H. L. Rittenhouse

Aircraft Noise Problem in Airport Vicinities—by C. E. Rosendahl

Some Effects of Engine-Fuel Variables on Exhaust Gas Hydrocarbon Concentration—by F. G. Rounds, P. A. Bennett, and G. J. Nebel

Control of Residual Stresses in Practice—by G. Sachs

Napier Nomad Aircraft Diesel Engine—by H. Sammons and E. Chatterton

New Chevrolet V-8 Engine—by R. F. Sanders

Cradle for New Power—by R. Schilling

Control of Propeller Noise in Turboprop Installations—by J. Schmey and R. M. Guerke

Wear Rates of Gears by the Radioactive Method—by F. L. Schwartz and R. H. Eaton

Structural Design of High-Speed Propellers—by F. B. Stulen

Some Concepts of Knock and Antiknock Action—by B. M. Sturgis

Reverse Thrust for Jet Transports—by J. Sutter

Pinwheels or Pistons?—by W. A. Turunen

Jet Noise—by J. M. Tyler and E. C. Perry

Abrasive Wear of Piston Rings—by C. E. Watson, F. J. Hanly, and R. W. Burchell

ABC's of Ultrasonic Inspection—by E. F. Weller, Jr.

Flame Photographs of Light Load Combustion Point the Way to Reduction of Hydrocarbons in Exhaust Gas—by J. T. Wentworth and W. A. Daniel

Control of Low-Temperature Sludge—by R. L. Willis and E. C. Ballard

Designing Adjustable-Speed V-Belt Drives for Farm Implements—by W. S. Worley

Progress of Torque Converters—by E. W. Zingsheim and M. M. Schall

1955 SAE GOLDEN ANNIVERSARY NATIONAL MEETINGS . . .

June 12-17
Summer Meeting
Chalfonte-Haddon Hall,
Atlantic City, N. J.

August 15-17
West Coast Meeting
Hotel Multnomah, Portland,
Ore.

September 12-15
Tractor Meeting and
Production Forum
Hotel Schroeder, Milwaukee,
Wis.

October 11-15
Aeronautic Meeting
Aircraft Production Forum,
and Aircraft Engineering
Display
Hotel Statler, Los Angeles, Calif.

October 31-November 2
Transportation Meeting
The Chase, St. Louis, Mo.

November 2-4
Diesel Engine Meeting
The Chase, St. Louis, Mo.

November 9-10
Fuels and Lubricants Meeting
The Bellevue-Stratford
Philadelphia, Pennsylvania

1956 SAE National Meetings . . .

January 9-13
Annual Meeting
The Sheraton-Cadillac Hotel
and Hotel Statler, Detroit,
Michigan

March 6-8
Passenger Car, Body,
and Materials Meeting
Hotel Statler
Detroit, Mich.

You'll Be Interested to Know . . .

VICE-PRESIDENTS have made the following appointments to their respective Activity Committees:

Air Transport—L. G. Romberg
Aircraft—L. M. Ball
Aircraft Powerplant—J. D. Redding
Fuels and Lubricants—C. L. Fleming
Passenger Car—J. S. Wintringham
Tractor and Farm Machinery—T. H. Morrell
Transportation and Maintenance—F. A. Hedemann

★ ★ ★

REAPPOINTED as SAE representative on the Daniel Guggenheim Medal Board of Award was M. G. Beard, assistant vice-president, Research & Development, American Airlines, Inc. He will serve for three years beginning October 1, 1955.

RICHARD HOPPER DeMOTT served as the Society's representative at ASME's 75th Anniversary Celebration, Stevens Institute of Technology, Hoboken, N. J., April 16, 1955. DeMott is chairman of the board and president of SKF Industries, Inc., Philadelphia.

★ ★ ★

A NUCLEAR ENGINEERING AND SCIENCE CONGRESS will be held in Cleveland, Ohio the week of Dec. 12–16, 1955. SAE will help to sponsor the Congress by contributing papers to the program on such subjects as **Radioactivity as a Sensitive Tool for Measuring Engine Deposits, Electrical Contact Studies with Radioactive Tracers,** and **Application of Radioactive Tracers to Engine Research.** Andrew L. Pomeroy, Staff Research and Development, Thompson Products, Inc., is serving as SAE's representative on the Program Committee.

Approximately 26 other technical organizations will cooperate with the Engineers Joint Council to prepare a well-rounded program.

★ ★ ★

BESIDES ATTAINING SECTION STATUS, Mohawk-Hudson has also extended its territory to include the following counties: Warren, Washington, Fulton, Montgomery, Schoharie, and Columbia Counties in New York; Berkshire County in Massachusetts; and Bennington County in Vermont.

from the Sections

Salt Lake

Field Editor C. W. Dunbar
March 8

AN OPERATING LIFE ABOVE 80,000 MILES is expected of future piston rings. Melvin E. Estey, chief research engineer, Perfect Circle Corp., made this statement. In addition, speaking about "Piston Rings—Art or Science?" Estey pointed to the following factors in future piston ring design:

1. Greater emphasis on high vacuum oil economy.
2. New materials for rings—such as powdered metals and new alloyed steels.
3. Fewer and narrower rings per piston in keeping with the short-stroke, large bore engines.

Oil control, ring groove, and cylinder wear are considered problems by Estey. Performance data have indicated advantages to chrome-plated steel rings, where superior strength of steel may be utilized without penalty of poor bearing properties.

Baltimore

Field Editor H. T. Cline
March 10

HORIZONS ARE TRULY UNLIMITED WITH FLIGHT REFUELING, according to Jack Sidebottom, engineer, Flight Refueling, Inc.

The PROBE and DROGUE system of refueling is outstanding for its simplicity and automatic operation. When refueling is to take place, the tanker trails a length of hose ending in an automatic reception coupling with a funnel shaped Drogue around it. The needle shaped Probe, attached to the nose or wing of the receiver aircraft, is flown into the Drogue at the relatively slow speed of 5 to 10 mph. A fuel tight coupling is automatically established and the transfer of fuel at a high flow rate is accomplished.

Flight refueling dates back to 1923 when a U. S. Army deHavilland stayed aloft for 37 hours and 15 minutes over Rockwell Field, San Diego, Calif., according to Sidebottom. Flight refueling proved itself in Korea. By refueling outbound and inbound, jet fighter radius is tripled. Refueled bombers deliver larger loads longer distances by taking off heavily armed, light on fuel.

Simultaneous refueling of three jet fighters from a single tanker is common with the Probe and Drogue system of flight refueling.

Atlanta

Field Editor D. J. Tolan
April 4

MISALIGNMENT AND EXCESSIVE PRELOAD ARE THE PRECURSORS OF PREMATURE BEARING FAILURE. These and other facts about bearings were divulged by Elmer Anderson, service manager of Timken Roller Bearing Co.

Some 70 members and guests heard Anderson explain the different types of bearings and their applications. He illustrated his talk with about 50 slides.

Mohawk-Hudson

Field Editor J. B. James
Feb. 7

AMERICANS WILL GO TO THE ATOM FOR ENERGY if the predictions of a 200 million population and a power consumption four times the present rate come true. That's what Sherman Naymark, of General Electric's Knolls Atomic Power Laboratory, told an interested audience.

Naymark traced the history of atomic development from Einstein's $E = mv^2$ to the present. He also covered the atomic submarine sea trial, in which he had a personal interest. He was for several years senior naval representative at the Argonne National

Laboratory on the Nautilus powerplant.

After a discussion of the Nautilus and the Sea Wolf, a General Electric film titled "The Atom Goes to Sea" was shown.

Northwest

Field Editor S. J. McTaggart
March 11

ELECTRONIC APPARATUS IS BEING DEVELOPED TO MEASURE RING FLUTTER by British engineers. Ring flutter can be roughly described as a very rapid contraction and expansion of the piston rings at a frequency several harmonics above engine speed occuring through certain critical engine speed ranges only. Their method, basically, consists of passing an electric current from the piston ring to the cylinder wall and measuring the rate of current flow interruptions.

Melvin E. Estey, Chief research engineer, Perfect Circle Corp., presented a complete and comprehensive history of the design and metallurgical development of automotive piston rings.

This history dates from massive square-sectioned piston rings used in the Model "T" Ford Era to thin-sectioned flexible rings used in today's wide bore, short-stroke, high compression engines. These new engines are posing several new piston ring problems. One is to provide satisfactory oil economy under high vacuum or no load operating conditions.

Texas Gulf Coast

Field Editor G. W. Putney
March 11

WHY SHOULDN'T A MAN BE JUST AS COMFORTABLE WHEN HE DRIVES HIS CAR as any other time, asks J. W. Duhn, assistant chief engineer, Electrical Section, Chrysler Corp. "Some Cold Facts on Car Air Conditioning" was the subject of his talk at the March meeting.

Design features of an automotive type air conditioning unit are based on ten targets. Design engineers consider these the requirements for a successful air conditioning installation:

1. An air conditioner for every car regardless of price class.
2. Rapid cool down at moderate road speeds.
3. Simple controls for the unit.
4. Good air distribution system.
5. Good filtering and dehumidification.
6. Enough fresh air to rid car of stale air.
7. Quiet operation.
8. No fogging of glass and metal surfaces inside car.
9. Good engine cooling with air conditioner installed.
10. A neat appearance both inside and outside the car.

Duhn pointed out that the wider use of car and truck air conditioning may also have an effect on future automobile styling. For instance, windows may become fixed, vent windows may disappear, one piece bubble canopies might come into use, and cooling ducts might be built right into the car body.

April 1

THE SECTION PUT ON A "JUNIOR REPUBLIC" DAY when the SAE Student Branch at Texas A & M played host to the Texas Gulf Coast Section at a combined meeting on the College campus.

The students put on a noteworthy performance. In addition to presenting an interesting program, they presented each member and guest with a souvenir ash tray that they made in metal working shop.

Technical part of the program featured a talk on the engineering achievements of an American-built sports car. It was presented by John L. Hooven, Chief Ford Car Engineer, Ford Motor Co.

—Submitted by E. L. Asch

Northern California

Field Editor R. E. Van Sickle
Jan. 26

800 TONS OF ORGANIC MATERIAL ARE EMITTED TO THE ATMOSPHERE EACH DAY from automobile exhausts, and another 400 tons per day are emitted from incinerators. Dr. L. M. Richards, assistant director of research, Stanford Research Institute, discussed the technical aspects of a problem of general concern—smog.

In his paper "Smog—the Product of Incomplete Combustion," Dr. Richards referred to the Los Angeles type smog. This smog differs from a "London fog" in that the Los Angeles condition involves a temperature inversion, no fog, presence of eye irritants, little sulfur dioxide, and the presence of products of petroleum combustion.

Characteristic contaminants in a smoggy atmosphere have been identified as: nitrogen oxides, 0.2 to 0.4 ppm; sulfur dioxide, generally not over 0.1 ppm; ammonia, up to 0.1 ppm; organic material, 1 ppm; aldehydes, some of which are definitely eye irritants, 0.3 to 0.6 ppm; and ozone, 30 to 60 parts per 100 million.

Dr. Richards also described instrumentation developed at Stanford Research for continuous recording of contaminants in the range of ppm and parts per 100 million.

Feb. 23

SIMPLICITY AND UTILITY keynote the intake manifold of the new Chevrolet V-8 engine. This casting not only acts as a fuel intake manifold, but also serves as a top enclosure over the tappet chamber. Incorporated in this same manifold are provisions for hot water heater take-off, cross-over for

From SAE Student Cameras . . .

Detroit Feb. 21

TIRES IN THE MAKING are inspected by members of the Student Branches of Detroit Section. The Section Student Activity meeting was held at the U. S. Rubber Co. in Detroit. Six Student Branches were represented in this activity.

Georgia Institute April 7

ATLANTA SECTION STUDENT CHAIRMAN William M. Law attends the Georgia Institute of Technology SAE Student Club meeting. He is working with Club chairman William Campbell on the program for this new active SAE organization.

St. Louis March 5

THE SIX CONTESTANTS in the recent student competition sponsored by St. Louis Section pose with the banner presented this year. Left to right: Paul Czysc, Parks College, first place winner; Valentine Dahlem, Parks, third place; Edward Clark, Missouri School of Mines, second place; Glen Smith, MSM; Charlie Vaughn, MSM; and Carol Carbaugh, Parks College.

Yale University March 11

ON JOINT TOUR with the Yale ASME student branch members through Wyman-Gordon die forging plant, Worcester, Mass. Construction of 35,000 and 50,000 ton presses was witnessed by the group.

exhaust heat to the carburetor, distributor mounting, oil filter, thermostat housing, water outlet to radiator, and water temperature gauge hole.

Highlights in the development and production of the Chevrolet V-8 were related by Russell F. Sanders, chief passenger car chassis design engineer for Chevrolet. As an authority on this engine, Sanders reported that the V-8 block is only 21¾ in. long and 9 in. from the bottom to the heads. High turbulence wedge-type designed combustion chambers are used to achieve control and smoothness of combustion.

Of particular interest is the valve train design. No rocker shaft is used and each rocker arm is assembled over a valve stem and push rod and retained by a fulcrum ball and lock nut. Oil flowing out the top of the tappet passes through the hollow push rods, and lubricates the rocker arms and valve stems.

Field Editor C. F. Carey
March 1

ECONOMIC, SOCIAL, AND MORAL ASPECTS OF ATOMIC ENERGY, as well as the more down-to-earth details of its industrial application, were presented in a stimulating talk by Prof. Lester E. Reukema to the South Bay Division.

Dr. Reukema, professor of electrical engineering at the University of California, gave a vivid picture of the potential good inherent in the proper use of atomic energy. Principally, **the standard of living of the entire world could be raised** to a level far higher than that of the United States right now. Even those countries not blessed with conventional sources of energy—coal, oil, and water power—could easily and economically be supplied with atomic fuels.

Professor Reukema's presentation followed a film and talk "Taking A Horseless Carriage Tour," by E. C. Lawrence, M. D., president of the Classic Car Club and director of the Horseless Carriage Club Santa Clara Valley Chapters. The audience, as members of SAE were understandably interested.

Detroit

Field Editor W. F. Sherman
March 7

"STYLING IS MORE THAN SKIN DEEP" is the title of the paper presented by Charles Jordan, General Motors Corp., as a member of the Detroit Junior Panel. The impact of styling on the automobile industry and the development of styling into a realm of its own were discussed by these Junior members under the general topic "Understanding Styling."

Jordan's paper was concerned with the stylists' part in the conception of the XP-39, ½ ton, pick-up truck. He covered the development from the idea stage to the assembled product.

Donald F. Kopka, Chrysler Corp., spoke on the topic "Is Styling an Exact Science?" His paper dealt with the language of the stylists and the basic principles upon which styling is founded, such as harmony, contrast, and balance.

"Dream and Sports Cars" were covered by Charles H. Phaneuf, Ford Motor Co. He presented a concise accumulation of the thinking that has gone on and is going on in the styling field.

Aiding the Junior members in the discussion period which followed the presentation of the papers were: Virgil M. Exner, director of styling, Chrysler Corp.; E. Anderson, chief stylist, American Motors Corp.; and D. R. DeLaRossa, manager of Mercury styling, Ford Motor Co.

Western Michigan

Field Editor W. C. Chaffee
March 15

THE MODERN EQUIVALENT OF THE GUILD SYSTEM is found in SAE, in that today's specialists band together for mutual help. Robert F. Kohr, SAE vice-president representing Passenger Car Activity and director of general engineering, Ford Motor Co., spoke to the Section on the history of the automotive industry and brought greetings from SAE President C. G. A. Rosen.

Kohr traced some of the engineering achievements made since prehistoric man first invented the sled and wheel, and compared modern man's standard of living to that of his forefathers who had thirty slaves. He touched on the development of the automotive industry from the turn of the century, and pointed out how it is a major factor in the nation's economy today.

At the conclusion of his words of greeting, the interesting movie "Tomorrow Meets Today" was shown. This depicts the birth of a modern automobile, and shows how $75,000 prototype cars are built and tested before approval for mass production.

Southern California

Assistant Field Editor R. S. Orchard
Feb. 7, 8, and 9

GLASS-REINFORCED PLASTIC MADE POSSIBLE A FUNCTIONAL BODY TO HOUSE GM'S POWER-PACKED FIREBIRD CAR. Discussion of the implications of this statement was the opening gun of an information-loaded three-day seminar on passenger engineering sponsored by the Section.

The first day was devoted to a talk and discussion of the plastic body for the turbine-powered Firebird car. R. F. McLean, of GM's styling section, disclosed the development problems and thinking behind this **"aerodynamic design in plastics."**

McLean said the car was designed for a speed of 250 mph. To date, it has reached 160 mph. But operations at the Bonneville Salt Flats will permit higher speeds to be attained. Despite its aerodynamic appearance, **the car cannot become airborne.**

"Directional Stability and Control of Wheeled Road Vehicles," was the title of the second day's presentation by Prof. Peter Kyropoulos, of California

So. Calif. March 14

From Section Cameras

BIRTHDAY CAKE CEREMONY was a high-point at the Section's Golden Anniversary meeting. Cutting the blue and gold cake are SAE Councilor W. G. Nostrand (left) and Section Vice-chairman Jack Hamilton.

Atlanta Jan. 28

INSPECTING THE INNARDS of a Lockheed C-130 cargo transport at the company's Marietta, Ga. plant are (left to right): Atlanta Section Vice-chairman Elmer Sanborn; L. C. Malone and P. H. Bremer, of Lockheed; and Atlanta Section Chairman Jack Reid.

Washington Feb. 15

GA MEETING of the Section featured (left to right) SAE Vice-president for Transportation & Maintenance Robert Gardner; Dr. Hugh L. Dryden, director, NACA; and SAE Past President D. P. Barnard.

Hawaii Feb. 21

VISIT TO SCHOFIELD BARRACKS by Section members was highlighted by talk by Maj.-Gen. H. B. Powell, in helmet above.

Institute of Technology. He noted that today's cars are designed mainly for ride comfort and safety, which permits the car to take a greater share of responsibility from the driver.

Good weight distribution calls for location of the heaviest masses up front. In some **European rear-engine cars**, the weight distribution detracts from stability unless distracted.

Members of staff of the Art Center School, of Los Angeles, headed the program on the third day in a session called "What About Passenger Car Styling?"

Panel members criticized modern car styling, calling attention to such features as excessive width, length, and use of chrome. They felt modern car designers have worked themselves into a dilemma by **the trend toward "slab-sidedness."** The only way of expressing individuality with this kind of styling is by extreme use of trim and color.

A film made by the photography students of the Art Center School was shown in which styling students depicted how they develop a new car design—from preliminary sketches to the finished product. Discussion was also focussed on the qualities that make for a good car stylist.

Field Editor W. E. Achor
March 7

800 CARS DAILY ARE PRODUCED in the Buick, Oldsmobile & Pontiac plant of GMC at South Gate, Calif. Approximately 100 members of the Section toured this plant where over 4500 people are employed, and 37 different models are produced currently at the rate of 55 per hr.

All cars are produced from dealers orders only. The car distributor's office issues orders by teletype to 27 different stations, giving color, trim, model, and accessory information for each car. Bodies are started about 14 hr prior to the start of the chassis. All body, engine, and sub-assemblies meet at exactly the right time on the chassis line, which delivers a finished car to inspection 1 hr and 10 min. after the frame is placed on the assembly line conveyor.

These cars are all subjected to a severe water spray test which must be passed before interior body trim is assembled. In an effort to constantly improve quality in the finished product, inspection at the end of the assembly line notes all assembly errors and advises the supervisors on the line by public address system.

—Submitted by R. S. Orchard
Assistant Field Editor

Field Editor W. E. Achor
March 14

FIFTY GOLDEN CANDLES ON A HUGE GOLD BIRTHDAY CAKE TRIMMED IN BLUE ICING illuminated Southern California Section's Golden Anniversary meeting. Some 400 members and guests helped celebrate.

J. I. Hamilton, Section Vice-Chairman, substituted for Section Chairman M. E. Russell in keeping a well-filled program moving smoothly.

Toward the end of the dinner Hamilton paraphrased one of the TV programs, announcing that those present were to be taken back to the SAE Golden Anniversary Annual Meeting in Detroit. This was the signal for lights out and the start of a recording of the introductions at the Detroit Masonic Temple.

As the strains of the SAE March started, a huge gold birthday cake trimmed in blue icing was wheeled into the meeting. Fifty golden candles provided the only illumination. When the cake, provided by Cal Loeb, manager of the Rodger Young Auditorium, was placed in front of the speakers' table, Hamilton and Councilor W. G. Nostrand, representing SAE President C. G. A. Rosen, cooperated in cutting the cake for distribution. The waitresses serving the crowd were decorated with blue shoulder sashes with gold letters reading "1905—SAE—1955."

The technical part of the program was ably carried by John F. Socolofsky, supervisor of Fuels & Lubricants Section, Socony-Vacuum Oil Co. He said combustion chamber deposits penalize engine performance. Multigrade oils help overcome problems brought on by deposits.

Deposits are harmful in two ways, noted Socolofsky. First, they take up space in the combustion chamber and increase the compression ratio. Second, they raise octane number requirement by causing **surface ignition and spark-plug misfiring.**

Tests show that the new type multigrade oils lower the octane number requirement increase (ONRI) brought on by deposits. The improvement is appreciable in some cases, slight in others. In one test series the switch to multigrade oils reduced the octane number requirement by an average of three octane numbers.

Socolofsky speculated that engines of the future will be designed to be **less sensitive to surface ignition** and coming gasolines may contain a surface ignition suppressor.

Washington

Field Editor R. J. Auburn
Feb. 15

IF FOREIGN COUNTRIES COULD PARTICIPATE MORE INTIMATELY IN THE ACTUAL CONSTRUCTION OF THE CARS THEY ARE TO PURCHASE AND USE, greater mutual advantage could be secured. Dr. D. P. Barnard, SAE past president and Deputy Assistant, Secretary of Defense, offered this convincing argument for promoting the use of automobiles in foreign lands by means of "cutting that country in on the business."

The occasion was the Golden Anniversary celebration meeting of Washington Section. Land, sea, and aeronautical topics were featured. Dr. Barnard discussed "Horizons of SAE." Dr. Hugh L. Dryden, director, NACA, talked on "Looking to the Future in Aeronautics." A film of the story of the Sea Wolf atomic-powered submarine completed the program.

Two prominent guests were introduced by Section Chairman D. K. Bonn. They were General Ben Kelsey and Robert Gardner. Gardner, from SAE Coun-

Montreal Feb. 24

GOVERNING BOARD GREETS PRESIDENT at Feb. 24 meeting. Seated, left to right, are: D. J. Munro, A. E. Jennings, SAE President C. G. A. Rosen, who was main speaker, Section Chairman H. W. Royl, L. F. Vauthier, and B. H. Miller. Standing, left to right, are: J. T. Dyment, F. H. Moody, E. D. Gray-Donald, F. B. Thompson, R. A. Harvey, W. G. Dewar, and C. P. H. Johnstone.

Pittsburgh March 1

TUBELESS TIRES need frequent inspection, said speaker H. W. Elliot (center), of B. F. Goodrich. With him are Section Chairman H. K. Siefers (right) and Technical Chairman A. D. Puckett.

Buffalo Feb. 22

PRESIDENTIAL VISIT to the Section drew large crowd. At the speakers table were (left to right) Section Chairman C. L. Nelson; SAE President C. G. A. Rosen; W. A. Turunen, who spoke on GM's gas turbine for the Firebird car; Section Program Chairman H. L. Jansen; and Section Past Chairman C. J. Lane.

Metropolitan Feb. 4

50th BIRTHDAY DINNER-DANCE helped the Section celebrate the Society's Golden Anniversary. Seated, left to right, are: T. L. Preble, toastmaster; W. E. Conway, general chairman; and Section Chairman L. F. Moody, Jr. Standing are: John A. C. Warner, SAE secretary and general manager; SAE President C. G. A. Rosen; P. M. Heldt, whose editorial gave birth to SAE; and W. P. Kennedy, first Chairman of the Section.

cil, presented greetings and a Golden Anniversary message from SAE President C. G. A. Rosen.

Field Editor R. J. Auburn
March 15

BIMETALLICS LET YOU EAT YOUR CAKE AND HAVE IT, the Washington Section was told by George T. Ladd, chief engineer, Al-Fin Division, Fairchild Engine and Airplane Corp.

Bimetallics is the **molecular bonding of dissimilar metals,** explained Ladd . . . such as aluminum and iron or magnesium and iron. Such a marriage gives you a good wearing surface without sacrificing weight.

Aluminum-iron brake drums are one of the applications mentioned by Ladd. The drum is cast in aluminum, with a cast-iron insert molecularly bonded to the inside of the drum where the brake shoe comes in contact. In addition to weight saving, the aluminum drum furnishes **far better heat dissipation.** Fins on the outside of the drum provide the equivalent of a low-speed blower. Result: less fade and far better brake performance.

Ladd also told of the use of bimetallics for diesel pistons, steel-backed aluminum bearings, and guided missile wings.

Pittsburgh

Field Editor D. W. Gow
March 1

TUBELESS TIRES ARE THE SAFEST TIRES YET to be supplied as original equipment on automobiles, stated W. H. Elliot, Field Engineering Department of the B. F. Goodrich Co. They display marked improvement toward puncture resistance, sidewall breakage, and non-skid properties.

One new requirement of these tires is **frequent inspection,** preferably at the time of greasing, to ensure that there are no nails or other particles imbedded in the carcass. These foreign bodies, while not causing air leakage, if left in will result in cord and tread damage.

Field Editor D. W. Gow
April 6

A DIE CAST ALUMINUM CARBURETOR is an interesting feature of the new Plymouth V-8 engine. This engine was the subject of a talk by Harold L. Welch, supervisor, Engine Development Laboratory, Engineering Division, Chrysler Corp.

In regard to carburetor icing, Welch stated that the superior heat conductivity of aluminum provided satisfactory protection against icing and eliminated the need for a water-jacketed throttle body. To prevent percolation and subsequent hot starting difficulties, the accelerator pump was relocated to the center of the float bowl.

In answer to a question concerning the use of a six volt ignition system, Welch stated that the two sets of contact points operating in parallel provided a much higher secondary voltage at high speeds than would be available from a single breaker. Entirely satisfactory operation is obtained with the six volt system and there appears to be no need of going to a 12 volt system, at least for the immediate future.

Buffalo

Field Editor D. I. Hall
Feb. 17

THE GAS TURBINE WILL PROBABLY ADD TO BUT NOT REPLACE GAS, DIESEL, OR STEAM ENGINES according to W. A. Turunen, head of the Gas Turbine Department, Research Laboratories Division, GMC. Turunen described the development of the gas turbine and gave illustrations of the experience gained in operating the turbine.

The automotive gas turbine is an outgrowth of the aircraft turbine. The objective was to develop a unit of utmost simplicity—an open cycle unit—one having no provision to recover exhaust heat.

Because gas turbines require a relatively large air fuel ratio in order to insure adequate cooling, size becomes a problem. Almost any fuel may be used satisfactorily in the unit, but it has been found that the unit operates most efficiently on the fuel for which the combustion chamber was produced.

Contrary to public opinion, noise does not have to be a problem. Absorbing materials such as glass fibre have been found to be very satisfactory in filtering out high pitch frequencies, with a resonator type muffler sufficient to quiet exhaust noise.

San Diego

Field Editor M. E. Morrison, Jr.
Feb. 8

150 POWERFLITE TRANSMISSIONS PER HOUR are being turned out at the Indiana Chrysler plant. Henry Ince, Central Service Division, Chrysler Corp., announced this fact. He and Harold Kingsbury, resident engineer of the Chrysler Los Angeles plant, were the speakers at this February meeting.

Kingsbury explained the principal workings of the powerflite transmission through the use of simplified hydraulic diagrams depicting each gear shift condition.

Ince brought out that their chief service problem was dirt in the hydraulic system. With the number of parts in one of these transmissions and the close tolerances required, it is remarkable that 150 such transmissions are being turned out per hour.

Hawaii

Field Editor F. L. Helbush
Feb. 21

A RIDE IN A TANK OVER ROUGH TERRAIN was the thrill of Hawaii Section's Golden Anniversary meeting at Schofield Barracks.

Major General Herbert B. Powell, Commanding General 25th Infantry Division, addressed the members and guests and extended his welcome.

A tour through the automotive shops, the 65th Engineering Battalion, the Tank Battalion, and the Aircraft Section of the Division proved of great interest to all.

Williamsport

Field Editor B. L. Sharon
Feb. 7

ENGINES OF THE FUTURE WILL BE NEITHER GAS NOR DIESEL, but a combination of both, Dr. P. H. Schweitzer of Pennsylvania State University told the SAE Williamsport Group. Slides were projected to illustrate the various types of diesel engines built both in this country and abroad.

The outstanding features of these engines were pointed out by the speaker. He stated that **the diesel engine would be improved if the air were controlled to fit the fuel and load demand.** Odor and smoke are more of a problem today because too many trucks are over-powered and engines are run hot with too rich fuel.

Dr. Schweitzer told the group that tests are now being conducted at Penn State using a commercial type diesel engine in which fuel is injected into the intake manifold. An increase of power in the order of 10% has resulted during preliminary tests.

March 7

A BEHIND THE SCENES VIEW of the development work leading to the new Chevrolet V-8 engine design was given to the SAE Williamsport Group by Max M. Roensch, director of laboratory tests for Chevrolet Motor Division of General Motors. This compact power plant **weighs 41 lb less than the standard six-cylinder engine.** More precise casting of the cylinder block by revised foundry practices plays a major part in reduction of weight. The speaker illustrated his discussion with slides.

At the start of the development, Roensch explained, it was possible to use a quart of oil in 200 miles of downhill driving. This, he said was increased to 1200 miles per quart.

The speaker, when asked about the future of diesel engines for passenger cars, stated that aside from the cost of the diesel, the noise would prohibit their use. The advantage of reduced fuel costs would be nullified by increased operation noise.

Milwaukee

Field Editor F. B. Esty
March 4

CADILLAC'S ANSWER TO THE PUBLIC'S CHALLENGE to design an engine of high output and efficiency that operates smoothly at all loads and speeds is represented in the development described by Harvey Mantey.

Mantey, supervisor of vehicle test, Cadillac Motor Car Division, GMC, described in detail how Cadillac engineers pioneered the modern engine era in 1949 by introducing engines with 7.5:1 compression ratio and 160 hp. Continued research and development both by Cadillac and the oil industry now allows Cadillac to offer engines with a 9:1 compression ratio and 250 hp. Mantey's paper is entitled "The Effects of Combustion Chamber Shape on Smoothness of Power."

Spokane-Intermountain

Field Editor T. H. Barker
March 10

SOLID TECHNICAL FARE spiced with a good color film made the March 10 meeting a noteworthy one.

In his talk "Piston Rings—Art and Science," M. E. Estey, assistant chief engineer of Perfect Circle Corp., discussed the progress to date in piston ring design. Following Estey's talk, a color film on the Indianapolis 500-mile race was shown by Paul Hindman, of Perfect Circle.

At the meeting, three judges were chosen for the student contest, to be held in Pullman on May 13. They are: Ai Corser, Howard Sell, and W. L. King. It was also announced that the Section would furnish judges to participate in the Science Fair at the Lewis & Clark High School.

Chicago

Field Editor P. P. Polko
March 8

A FITTING TRIBUTE TO A VETERAN SAE MEMBER AND ENGINEER, Dr. W. S. James, vice-president and director in charge of engineering for the Fram Corp., was the crowd of 500 attending this meeting. The Chicago Section Fuels-Lubricants and Transportation-Maintenance Activities worked together to provide a memorable program.

Dr. James' subject, "What Price Performance," was a combined discussion of recent automotive developments and the problems in fuels, lubricants,

and maintenance to which these developments gave rise.

Not one to weary his audience, Dr. James frequently turned from the serious aspects of his paper to flash laugh-provoking cartoons on the screen to illustrate his points.

True in all of life, but especially true in engineering—the normal state is change, with the dreams of today becoming the realities of tomorrow, suggested Dr. James. To summarize the situation which faces men in all fields of human endeavor, but particularly those in automotive activities:

1. The normal state is change.
2. Man's imaginations and dreams are the motivating power that forces their fulfillment.

—Submitted by E. A. Comfield

Field Editor P. P. Polko
March 21

HARDNESS OF DUST PARTICLES, AS WELL AS SIZE OF PARTICLES, ACCOUNTS FOR WEAR on lubrication and combustion systems of automotive engines. Dr. W. S. James, vice-president and director in charge of engineering, Fram Corp., presented this fact in his paper "Abrasive Wear of Engines."

By the use of slides, Dr. James outlined and illustrated the test equipment, conditions, and early results of dirt contamination of the lubrication and combustion systems on automotive engines. Analysis of these data resulted in a standardization procedure for reporting all future test results. This procedure was followed throughout his series of slides in reporting the results of many varied tests.

Some general conclusions were drawn from the testing conducted by Dr. James. Some of these were:

1. Engines wear rather uniformly with time under similar conditions, except possibly for bearings.
2. Quantity of dust is more important than the length of time the dust is there, except possibly on bearings.
3. Clearances have an effect, but not in the same way on all parts.

—Submitted by D. W. Miller

Texas

Field Editor H. Anderson
March 11

PREVENTIVE MAINTENANCE MUST BE TAILOR-MADE to the particular vehicle and type of operation. R. W. Thomas, director of transportation for Quality Bakers of America, Inc., made this statement at the March meeting. He and W. E. Lessing, chief engineer of Central Freight Lines., Inc., two prominent men in the field of preventive maintenance, presented their views on economical vehicle operation.

Thomas told of the preventive maintenance system used on the small size trucks of the Quality Bakers of America. He reviewed some of the various maintenance forms used by different companies, showing how they varied from relatively simple to very elaborate check sheets. Four important factors that he felt affected good preventive maintenance were:

1. Top management must approve it.
2. Spare vehicles must be available, one for every ten trucks.
3. Adequate trained personnel and space.
4. Proper standard and special tools.

Lessing spoke on preventive maintenance for large trucks. The definition of preventive maintenance as told by Lessing is "any system of maintaining the vehicles that keeps the boss from firing you and hiring someone else."

Some of the basic necessities of a good preventive maintenance system as he saw them were:

1. It must have management approval.
2. The maintenance intervals must be modified to meet the capabilities of each truck.
3. Preventive maintenance sheets should constantly be revised to prevent their becoming obsolete.
4. Cost accounting must be maintained to show management the results of preventive maintenance.

—Submitted by A. P. Johnston

Canadian

Field Editor F. G. King
Feb. 23

SAE PRESIDENT'S NIGHT was celebrated at the February meeting. The Section was honored by the presence of President C. G. A. Rosen.

President Rosen gave an inspiring talk on "In Quest of Creativeness." A traditional ceremony also took place at a luncheon at the Granite Club attended by the Governing Board of the Section. Warren B. Hastings, general manager of Ontario Motor League and a past chairman of the Section, presented President Rosen with an umbrella cane.

March 16

IN STAGE 4 OF PASSENGER CAR DESIGN the appearance factor will continue to lead, and the mechanism to adjust itself to the shape of the vehicle. Maurice Olley, director of research and development of Chevrolet Motor Division, GMC, made this statement in presenting his SAE Golden Anniversary Article to Canadian Section. This paper "Progress in Passenger Cars" (See p. 20 of February SAE Journal) was presented at the Section Golden Anniversary meeting.

In commenting on the Golden Anniversary, Olley pointed out that the SAE is actually still in its infancy. ASME is celebrating its 75th Anniversary and the American Society of Civil Engineers has recently celebrated its Centennial.

About

JOHN K. TOMKO is now chief engineer of the Oliver Corp. Cleveland Crawler Tractor Plant. He has been assistant chief engineer since 1953 and has been associated with Oliver Corp. for over 16 years.

Tomko has been a member of various SAE committees. At present he is serving on the Construction and Industrial Machinery Technical Committee Sub-Committee XV on Winterization, and is secretary for Sub-Committee I on Standardization of Tractors and Mounting Equipment.

Tomko

Rumely

V. P. RUMELY has recently retired as senior vice-president, manufacturing, of the Crane Co., Chicago. He had been with Crane 18 years.

Previous to his service with Crane, Rumely spent 22 years in the automotive industry with Buick Motor Division of GMC and Hudson Motors Division of American Motors Corp.

Rumely served as SAE vice-president representing Production Engineering in 1935. He has been a member of SAE since 1923.

His plans for the future include travel throughout the South and later in Europe. Meanwhile he has "a lot of fishing, hunting, and gardening to do."

GEORGE C. MILAN has become district manager in the new district office of Cook Electric Co., Baltimore, Md. He was formerly installation engineer with Aero Engineering Co., New York division of Garrett Corp.

Milan

Esty

F. BURROWS ESTY has been advanced to chief engineer of Wisconsin Motor Corp. after serving as assistant chief engineer since 1948. He succeeds A. F. Milbrath (recently deceased), vice-president and chief engineer for many years, who retired in Oct.

Esty has been active in the Internal Combustion Engine Institute and on committees guiding the Engine Standardization Program of the Department of Defense.

D. E. JAHNCKE has been appointed manager of the Manufacturing Standards Department of the Lincoln-Mercury Division, Ford Motor Co. He had been assistant manager of the Manufacturing Engineering Department.

R. C. CULLEY, formerly section supervisor, Quality Control Department of the Division, has become manager of Manufacturing Engineering.

MILO DEAN has been appointed assistant manager of the Quality Control Department, a position he held in Ford Division.

JAMES C. BURKE has recently joined Boeing Airplane Co. as junior engineer. He has been research assistant with M.I.T.

MAURICE NELLES is now concerned with research development and diversification as an executive with Technicolor Motion Picture Corp., Hollywood. He had been director of Borg-Warner Corp.'s Central Research Laboratory.

JAMES J. NANCE, president of Studebaker-Packard Corp., has been elected president of the Automobile Manufacturers Association replacing the late George W. Mason.

In addition, new directors were named. Among them are **L. L. COLBERT,** president of Chrysler Corp., and **J. L. BROWN,** vice-president of American Motors Corp. Colbert fills a vacancy created by the resignation of **B. E. HUTCHINSON,** retired chairman of the finance committee of Chrysler Corp.

BOB W. SHEFLIN has moved to the New England Machine & Tool Co., Berlin, Conn., where he will be general manager of the Plainville Division. In this new position he will have the management of the division making compressor and turbine blades, blade masters, patterns, cams, and other parts with unusual contour problems.

Previous to February, he served as chief of the Fabrication Division, Lewis Flight Propulsion Laboratory of the NACA, Cleveland.

ALLEN L. BROWNLEE has been elected vice-president of Wico Electric Co., West Springfield, Mass. In addition to his executive duties, he will be in charge of manufacturing, sales, and engineering. He had been serving as 2nd vice-president in charge of engineering.

HERMAN L. WECKLER has been elected to the board of directors of Clevite Corp.

Weckler, who was elected vice-president and general manager of Clevite last year, first joined the company in 1953. For 13 years previously he was vice-president and general manager of Chrysler Corp., where he also was a director.

JOHN H. CAULEY, who had been fleet sales engineer with General Motors Corp. Truck & Coach Division, is now Charlotte zone manager, Charlotte, N. C., for the same corporation.

D. P. HURLEY, JR., president of New England Wheel & Rim Co., Boston, was the recipient of the Distinguished Distributor's plaque, presented by Monroe Auto Equipment Co. for sales performance on Monroe shock absorbers in 1954.

New England Wheel & Rim Co. was selected on a national basis as the outstanding warehouse distributor for Monroe in the light of their merchandising and sales performance.

Presentation was made at a large jobber meeting recently held in Boston, where 150 wholesalers were guests of the New England Wheel & Rim Co.

Hurley

Gruitch

JERRY M. GRUITCH, director of research and development of ACF Industries, Inc., has recently been elected to membership in Sigma Xi, the national scientific research honorary society at the University of Michigan.

Gruitch was given this recognition for his basic and original research work connected with the development of high-speed refrigeration compressors, as well as for research developments in the ordnance field.

SAE Members

ALBERT I. ALSTROM, product engineer of Wico Electric Co. since 1945, has been elected executive sales engineer. This newly created position will coordinate more closely the functions of engineering and selling.

DON PARKIN, formerly aircraft sales manager—Fontana Division, Taylor Forge & Pipe Works, is now general manager of Larkin Engineering Co. in Maywood, Calif. The company manufactures hydraulic and pneumatic actuating cylinders.

Parkin has been very active in the SAE Southern California Section. He has been Section vice-chairman of Aircraft Powerplant Activity, a past-chairman of Social Activity, and Membership chairman. He is again taking on the chairmanship of Social Activity for the 1955–56 Section year.

Parkin

Leingang

WILLIAM C. LEINGANG, former assistant general manager, Exide Automotive Products Division of the Electric Storage Battery Co., has been named assistant to the president.

Leingang joined the company's Detroit sales office in 1923, shortly after graduation from the University of Michigan with a degree in electrical engineering.

MARSHALL D. McCUEN has been named superintendent of the 90-mm cannon plant of Oldsmobile Division, GMC. He was night superintendent of the Saginaw St. plant.

H. R. ESHLEMAN has resigned as president and general manager of Springfield Machine & Stamping, Inc. He will devote his entire time in service to Pullman Industries of Pullman, Mich., manufacturers of plain and stainless steel stampings and rolled sections for the automotive industry.

HAROLD S. VANCE, chairman of the executive commitee of Studebaker-Packard Corp., has been named to head a new Office of Defense Mobilization Advisory Committee on Components and Production Equipment. The committee is to advise the Government on the component shortage study program and also on Federal policies and programs dealing with machine tools.

JOSEPH C. FOX is now die casting consultant with offices in Toledo, Ohio. He offers counseling on all matters pertaining to the chemical and metallurgical phases of die casting.

Fox had been chief metallurgist for Doehler-Jarvis Division of National Lead Co., Toledo. He had been associated with Doehler for over 36 years in connection with the technology of the die casting process.

He has served on many SAE committees, among them the SAE Engineering Materials Activity Committee, the Cast Aluminum Alloy Sub-committee, and the special team on the SAE—War Engineering Board that worked with the Signal Corps to study the effect of temperatures on electrical equipment in 1943.

WALTER BURKE STARKS, who has been power plant engineer for Chicago & Southern Airlines, Inc., Memphis, Tenn., has taken a position as senior engineer-Power Plant Division, Trans World Airlines, Kansas City, Kans.

EARL H. SMITH, Packard division development engineer and director of Packard Proving Ground operations, has retired after more than 40 years of service in the automotive industry. He leaves Packard after having completed a major role in the product development program which brought to production the advanced lines of 1955 model Packard and Clipper automobiles.

Smith had been with Packard since 1934, when he joined the company after having been assistant chief engineer for Pontiac Motor Division.

A member of SAE for 30 years, Smith served as vice-president representing Passenger Car Activity in 1936 and again in 1944. For 18 years he has been a member of the SAE Passenger Car Activity Committee.

Smith

Woodbury

RICHARD S. WOODBURY, vice-chairman of SAE Metropolitan Section, has been appointed director of the Institute of Inventive Research Division of Southwest Research Institute. He will direct all phases of the Institute's work in finding and developing new patents for commercial use and research to develop new inventions. Previously he had been secretary-treasurer of the Lanova Corp.

Formerly a member of SAE Southern New England Section, he was active on the governing board for that Section. With Metropolitan Section he has held the offices of chairman of the Membership Committee, Section treasurer, and Section vice-chairman.

F. J. WALLS, in charge of the Detroit Technical Field Section of the Development and Research Division of International Nickel Co., Inc., has been chosen as the American Foundrymen's Society 1955 Charles Edgar Hoyt Lecturer. The lecture will be given during the A. F. S. convention at Houston, Texas, in May.

Walls was selected because of his continued interest in improving the quality level of foundry education, his long service to the organization, and his contributions to the foundry industry as a whole.

SAE Father and Son

Robert F. Kohr (M '20) chats at SAE Passenger Car, Body and Materials Meeting in Detroit with his son Robert H. Kohr (J '52). Robert F. is director, General Engineering Office, Ford Motor Co. Robert H. is serving as research engineer, Research Laboratories Division, GMC. Both are active members of Detroit Section, and Robert F. is SAE vice-president representing Passenger Car Activity.

WILLIAM D. ALLISON, previously project engineer for Hudson Motor Car Co., has taken the position of vice-president and executive engineer with Motor Research Corp. in Detroit. His duties will include design and consulting services on torsion bar spring suspensions.

Allison is the inventor and patentee of the torsion bar automatic leveling spring suspension currently introduced and first used on American built automobiles.

ALBERT E. WEIGHTMAN has been named general manager of Tide Water Associated Oil Co. (Canada), Ltd. He has been sales manager at the firm's Toronto offices and has been associated with Tide Water since 1941.

BEN G. VAN ZEE, chief engineer, Automotive Engineering Division, Minneapolis-Moline Co., has been elected president of the Internal Combustion Engine Institute. This Institute represents manufacturers in the high-speed gasoline and diesel engine fields.

Elected as secretary of the Institute was **H. W. SMITH**, consulting engineer, Engine Division, Caterpillar Tractor Co.

J. E. HEUSER, general sales manager of the LeRoi Division, Westinghouse Air Brake Co., former president of the Institute, has been elected to the board of directors.

REXTON S. RAINEY has been appointed chief engineer of the Oil Seal Division of Yale Rubber Manufacturing Co., Sandusky, Mich. Yale Rubber manufactures over 3000 different molded and extruded industrial rubber products.

Rainey formerly served as vice-president and general manager for Allis Seal Corp., Chicago.

DR. B. D. KALELKAR is now industrial advisor (Engineering) to the Ministry of Commerce & Industry, Development Wing, New Delhi, India.

Dr. Kalelkar has been serving as director-in-charge, Hindustan Electric Co., Ltd., New Delhi.

JOHN Z. DeLOREAN recently joined Packard Division of Studebaker-Packard Corp. as staff engineer, Advanced Engineering. His responsibilities will include advanced product planning, design, and development.

DeLorean had served as assistant transmission engineer with Packard Motor Co.

EIBE W. DECK, vice-president of Wico Electric Co., retired from Wico to accept the position of vice-president of the Lunkenheimer Valve Co., Cincinnati, Ohio. Deck joined Wico in 1951 from Borg-Warner Corp. He has been serving as vice-president and works manager with Wico since then.

LESLIE L. ANDRUS, vice-president of American Wheelabrator & Equipment Corp., Mishawaka, Ind., and executive head of its Dust & Fume Control Division, has been elected to the board of directors of that corporation.

The division headed by Andrus is known to many industries for work toward prevention of atmospheric pollution.

Andrus

Fox

GUY FOX has been named general manager of South Eastern Motors, Inc. of Hollywood, Fla. He came to South Eastern from GMC Truck & Coach Division, for whom he served as retail store manager in Cleveland.

South Eastern distributes Triumph and Doretti sports cars in all states east of the Mississippi.

WILLIAM O. SWEENY, assistant vice-president of Arwood Precision Casting Corp., announces that Arwood operations at its fourth investment casting plant in Los Angeles are now in full swing. This plant resulted from the demand of western industry for vital parts for aircraft, guided missiles, and many commercial applications.

EDWARD D. MEEKER has been elected to a newly created position of executive vice-president of Wheels, Inc. to comprehend certain management and administrative responsibilities. These new duties are in addition to the overall direction of sales, which Meeker has held as director of sales.

Meeker

Helwig

OLIVER K. HELWIG, associated with Fisher Body Division, GMC, since 1924, has been appointed director of Process Development Activities of Fisher Body. He has been manager of Fisher Body plant No. 21 in Detroit.

ROBERT K. WELCH is now account manager in the New York offices of E. I. du Pont de Nemours & Co., Inc. He had been sales-service representative for du Pont in Chicago.

RALPH SWITZER has been promoted to the position of director of Research & Development Engineering for Wisconsin Motor Corp. He has been with Wisconsin Motor since 1928, serving as research & experimental engineer.

Active for many years in the Milwaukee Section of SAE, he is at present chairman of that Section.

Switzer

Brazier

J. V. BRAZIER is now operations manager for the Dealers Refining Co., Wichita, Kan., which specializes in the manufacture and distribution of hydraulic lubricants. He has offices in Tulsa, Okla.

He had formerly been vice-president of Petroleum Marketing Co., also of Tulsa. In addition, he had been in partnership with Gaino Oil Co.

Active in SAE affairs, Brazier was general chairman of the SAE National Fuels and Lubricants Meeting held in Tulsa in 1948.

MARSHALL VAN WINKLE III has taken a position with Jersey Marine Co., Red Bank, N. J. as manager of the outboard department. He has been serving with the U. S. Coast Guard.

FREDERICK OSANN, JR. has been appointed staff executive and director of Forward Planning for the Automotive Body Division of Chrysler Corp. He has been plant manager of the Chrysler Jet Engine Plant during the past 18 months.

Osann

Hardy

JAMES A. HARDY has been appointed executive engineer of the Schwitzer-Cummins Co., Indianapolis. He had formerly served as chief research engineer for the company.

REYMONT SZELIGA, former development engineer for Aircooled Motors, Inc. of Syracuse, N. Y., is now technical engineer for the Aircraft Gas Turbine Division Jet Engine Department of GE.

LESTER L. ROBINSON has been appointed assistant chief engineer of the Aircraft Accessories Division of Pierce Governor Co., Inc. He joined the organization in September of 1954 as a project engineer and was previously associated with Bendix Aviation Corp.

SHERMAN L. BREMER is now associated with GMC Truck & Coach Division as product representative. He will be responsible for the handling of service problems arising in gasoline and diesel engines in large truck units which cannot be solved by field personnel.

He had formerly been serving as sales trainee with the Detroit Diesel Engine Division of GMC.

J. S. PARKER has been appointed general manager of the General Electric Co. Aircraft Gas Turbine Division. He will be responsible for the operation of five departments within the Aircraft Gas Turbine Division, three with headquarters in Cincinnati and two at Lynn, Mass. Parker has been manager of the Small Aircraft Engine Department.

GUY C. SHAFER has been named to replace Parker as general manager of the Small Aircraft Engine Department. He has been manager of the J47 C-E engine project.

WILLIAM G. MEARS is on leave of absence from Socony-Vacuum Research & Development Laboratories for duty in the USN. He has been serving as junior technologist in charge of diesel test engines.

W. C. ANDERSON has moved to the Engineering Staff of Ford Motor Co., Dearborn, Mich. He had been a member of the Lincoln-Mercury Division in Detroit as product analyst.

2nd Lt. LOREN D. GARDNER is serving with the U. S. Army as assistant project engineer at the White Sands Proving Grounds, N. M. He had formerly been junior engineer with Boeing Airplane Co., Seattle.

At White Sands Proving Grounds he will be concerned with the coordination of all work on a surface to surface missile program.

J. L. SEWELL has been elected president of Delhi-Taylor Oil Corp., Dallas, Texas. He had formerly served as vice-president of Taylor Oil & Gas Co., Taylor, Texas.

JOHN B. JACKSON, JR. has recently joined the Tractor & Implement Division, Ford Motor Co. as project engineer in charge of the dynamometer laboratory. He had been concerned with experimental engineering for Budd Co.

SAE JOURNAL would very much like to print your job promotion, change of company affiliation, or professional recognition or awards you may receive.

Please address any such items to:

News Editor
SAE Journal
29 W. 39th Street
New York 18, N. Y.

ROBERT W. STODDARD has been named president of Wyman-Gordon Co., Worcester, Mass. He has been serving as vice-president of the firm.

Another appointment in the company concerns **GEORGE F. FULLER,** who has been made honorary chairman of the board of directors. Fuller has been with the company 67 years, starting as office boy.

L. A. de GEBERT, Diesel production methods investigation, Davey, Paxman & Co., Ltd., Colchester, England, has revealed a well kept secret.

De Gebert became the Count of Noyan in 1952 upon the death of his uncle Jean Adam Louis de Gebert.

This title makes de Gebert head of one of the oldest families of the French Touraine. He hopes that his eight-year-old nephew will one day become the Count.

RAYMOND P. KOSTER has joined Bowsers, Inc., Fort Wayne, Ind., as design engineer. He had served in the same position with Tokheim Corp. in Fort Wayne.

PHILIP A. SIDELL is now with Line Material Co., Milwaukee, as consultant to the president. He has been associated with National Presto Industries, Inc., Eau Claire, Wis., as director of engineering.

GEORGE R. ASCHAUER has recently become supervisor of Mechanical Design Engineering, General Products Division of Twin Disc Clutch Co., Racine, Wis. He had been special product engineer.

EVERT L. VENSTROM has been named supervisor of Mechanical Engineering for the Hydraulic Division at Rockford, Ill. He had been serving as design engineer for that division, in which **MARVIN W. DUNDORE** has been promoted to supervisor of Circuit Engineering. Dundore had formerly been experimental engineer.

ROBERT E. SHEAHAN has joined A. C. Gilbert Co., New Haven, Conn., as appliance development engineer.

Sheahan was previously associated with Picker X-ray Co., Cleveland, as project engineer. He designed their 1500 Currie Cobalt 60 Teletherapy machine for treating cancer.

ROGER D. WELLINGTON has become assistant director, Engineering Laboratory, Detroit Diesel Engine Division of GMC. He had been project engineer.

EMIL F. HALIK has retired as equipment superintendent for Oregon State Highway Commission, Salem, Ore. He has been in retirement as of Feb. 28, 1955.

FRANKLIN C. LINDSAY has taken a position with North American Aviation, Inc., Columbus, Ohio, as research engineer in the Engineering Research Laboratory. He has been development engineer, Aircraft Laboratory, Buick-Oldsmobile-Pontiac Assembly Division, GMC.

GORDON E. WHELPLEY is now associated with Micro-Precision, Inc. of Evanston, Ill. as senior product engineer. He had served in the same position with Houdaille-Hershey Corp. With Micro-Precision he will be in charge of products on hydraulic controls and development.

PAUL W. WETZEL has been promoted to the position of chief engineer—Three River Works, Fairbanks, Morse & Co., Three Rivers, Mich. He had served as diesel engineer.

Continued on page 102

Obituaries

HAROLD BROWALL

Harold Browall, contact metallurgist for Inland Steel Co., Chicago, died in March. He had been with Inland Steel since 1929.

Browall played an active part in many phases of SAE work. He had been a member of the SAE Technical Board from 1952 through 1954. He was a prominent member of the Iron and Steel Technical Committee, serving on Panel A—Steel Producers. Also he has been chairman of Division VII—Carbon Steels since 1946.

Born in Pittsburgh, Pa., Browall attended Pennsylvania State College and Carnegie Institute of Technology.

He started in industry as mill metallurgist with Carnegie-Illinois Steel Co., Gary, Ind. He also served as chief inspector for LaSalle Steel Co, Hammond, Ind.

HERMAN STOLL

Herman Stoll, consultant on forging and casting problems in Detroit, died Feb. 19. He became a member of SAE in 1919.

Stoll has been associated with General Motors Corp. since 1920. His work has been centered in the drafting and designing fields with GMC Standards Department, Chevrolet Motor Division, GM Overseas Operations Vauxhall Development Section, and GMC Detroit Diesel Engine Division. He also spent time in Germany as a research engineer with Adam Opel, A.G.

During 1917 Stoll served with the Bureau of Standards in Washington, D. C., as chief draftsman. He worked with J. G. Vincent and G. L. McCain in the Liberty Motor design section at that time.

SIDNEY B. SHAW

Sidney B. Shaw died Feb. 2. He had been an engineering consultant in San Francisco.

Shaw started his career as engineering assistant with J. G. White & Co., Inc. in 1912. He moved in the same year to the Pacific Gas & Electric Co. of San Francisco, with whom he served as automotive engineer for 42 years.

He graduated from Stanford University with an A.B. in Electrical Engineering in 1912. As a member of SAE he has been very active in the Northern California Section, serving as chairman in 1928–1929, as vice-chairman several years, and on many committees. He has also served on the SAE Transportation & Maintenance Activity Committee.

VICTOR GAGE

Victor Gage, Professor of Mechanical Engineering, Emeritus, of Cornell University, died Dec. 12. He had been a member of SAE since 1921.

Prof. Gage became assistant professor of experimental engineering at Cornell in 1921. Previously he had served as engineering consultant with the National Advisory Committee for Aeronautics during World War I. Also he was a mechanical engineer with the Bureau of Standards during 1919–1920.

A graduate of Cornell, he received his M.E. in 1906 and his M.M.E. in 1910. He was a member of Sigma Xi and ASME.

NATHAN LAZARNICK

Nathan Lazarnick, president of Nathan Lazarnick, Inc., N. Y., photographic illustrator, died Jan. 20.

Lazarnick was engaged in the photography of automotive equipment for catalogue illustrations and for technical and popular publications. He specialized in automotive photography and had a singularly complete photographic history of the automotive industry in this country.

During World War I, he photographed a good deal of Ordnance apparatus for instruction books and other uses by the Ordnance Department in Washington.

Lazarnick had been a member of SAE since 1921.

ROBERT B. HAYNES

Robert B. Haynes, management and manufacturing consultant, died Feb. 25. He had been a member of SAE since 1920.

Haynes was born in St. Louis in March, 1898. His first contact with the automotive industry was in 1916 when he joined Packard Motor Co. as tool designer in the automatic screw machine division. During the next seven years he widened his tooling experience in the employ of such firms as Timken-Detroit Axle, Studebaker, and Cadillac.

From 1923–1935 he served with Electric Auto-Lite Co. as methods engineer in the ignition division, becoming manager of that division in 1929. He joined Spicer Mfg. Co. in 1937 as master mechanic. When that company became a division of Dana Corp., Haynes became manager of the division and later vice-president.

He was a member of the American Society of Tool Engineers.

ROBERT A. SUCZEK

Robert A. Suczek, chief research engineer for Hudson Motor Car Division, American Motors Corp., died recently. He had been ill for three years.

A native of Czechoslovakia, Suczek attended the University of Engineering in Buin, Czechoslovakia and the University of Heidelberg. He was a charter member of the Detroit Society of Mechanical Engineers. He was a member of the American Society of Mechanical Engineers and had been a member of SAE since 1929.

An inventor, he was awarded a medal by the Franklin Institute of Philadelphia for an invention used on Navy ships during World War I.

SAE Section Meetings . . .

Buffalo—May 17

Country Club. Dinner 7:00 p.m. "Sports Car Show"—Morey Rose, Chevrolet and J. R. Gillette, Lincoln-Mercury.

Canadian—May 27

Genosha Hotel, Oshawa. Dinner 7:00 p.m. K. E. Coppock, assistant chief engineer, Fisher Body Division, G. M. C., Detroit. Golf Tournament in the afternoon.

Central Illinois—May 23

American Legion Hall. Dinner 6:30 p.m. Meeting 7:45 p.m. "Torque Converters"—W. B. Gibson, sales manager, Twin Disc Clutch Co., Rockford, Illinois.

Chicago—June 3

South Shore Country Club. Annual Ladies Night. Dinner, entertainment, floor show and dancing.

Cincinnati—May 23

Engineering Building. Dinner 6:30 p.m. Meeting 8:00 p.m. Film on 1954 Pan-American Road Race.

Cleveland—May 13 and June 23

May 13—Dinner-Dance.
June 23—Golf Outing.

Colorado—May 18

My-O-My Supper Club. Dinner 7:30 p.m. Annual Ladies Night. Dinner-Dance in honor of SAE 50th Anniversary.

Metropolitan—May 18

Garden City Hotel, Garden City, L. I. 7:45 p.m. Air Transport Activity Meeting. "How Bell's XV-3 Convertiplane Was Developed" — Bertram Kelley, chief engineer, Helicopter Division, Bell Aircraft Corp.

Mohawk-Hudson—June 3

Locomotive Club, Schenectady. "Ladies Night."

Montreal Section—May 16

"Rubber on Wheels (Panel Discussion)

New England—June 6

Woodland Country Club. Dinner 7:00 p.m. "Annual Outing."

Northern California—May 18

1955 SAE President C. G. A. Rosen. Golden Anniversary Meeting. "In Quest of Creativeness."

Philadelphia—May 20

Springhaven Country Club. Dinner 7:00 p.m. Cocktails 6:00 p.m. Ladies Night. Golf and bridge.

Pittsburgh—May 18

Wenango Country Club, Reno, Pa. Dinner 6:00 p.m. Meeting 8:00 p.m. "Where Did It Come From"—R. S. J. Pigott, consulting engineer. Special Features: Golf game and prizes. Pittsburgh to Oil City run of the Western Pennsylvania Horseless Carriage Club and Display of their Antique Automobiles.

San Diego—May 25 and June 17

May 25 — State College Campus. Dinner 6:30 p.m. Meeting 7:45 p.m. "Growing In Engineering"—1955 SAE President, C. G. A. Rosen. Golden Anniversary Meeting.

June 17 — Mission Valley Country Club. Annual Social and Ladies Night. Dinner-Dance.

Southern New England—May 20

Spokane-Intermountain—May 13

Desert Caravan Inn. Dinner 7:00 p.m. Meeting 8:00 p.m. Student Group (Paper Contest). — Students from Washington State College, University of Idaho and Gonzaga University.

Syracuse—May 12

Sidney, N. Y. "Ignition Analyzer on Internal Combustion Engines"—C. H. Welch, chief engineer, Scintilla Magneto Co., Sidney, N. Y.

Texas—May 13

Amon Carter Airport. "Sport Cars."

Texas Gulf Coast—May 13

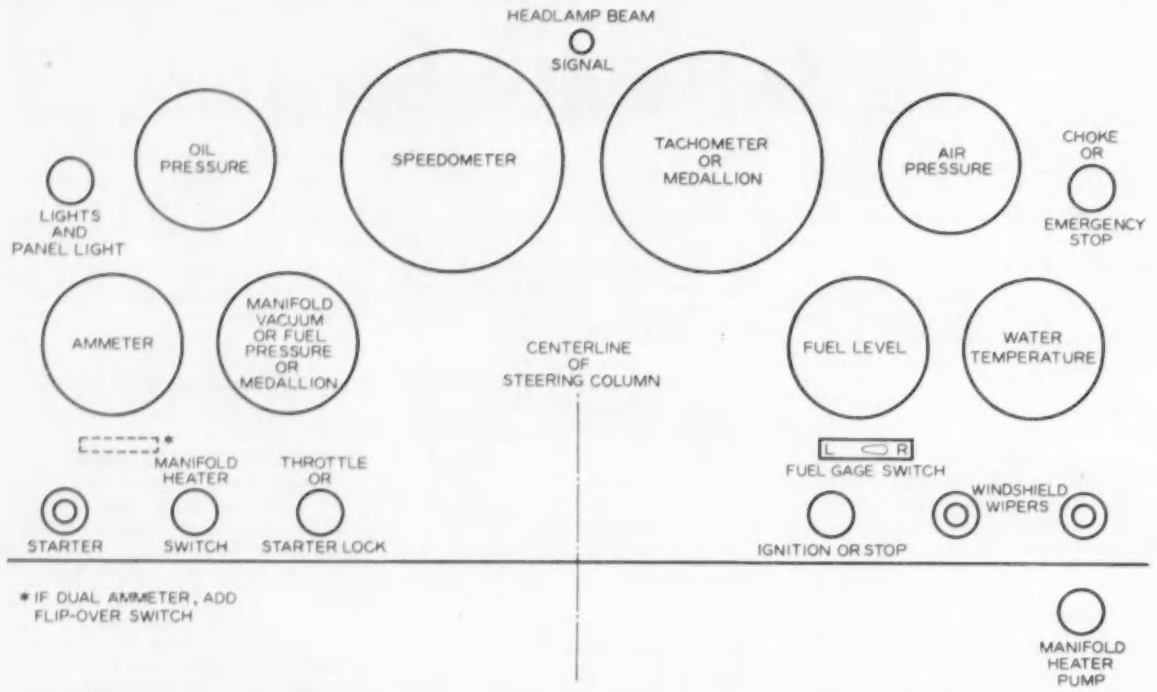
Ye Old College Inn. Dinner 7:00 p.m. Annual Ladies Night and Golden Anniversary Meeting. W. C. Heath, chief engineer, Solar Aircraft Co., will present SAE President's greetings.

Washington—May 17

Occidental Restaurant. Dinner 7:00 p.m. Meeting 8:00 p.m. "The First Rocket Ship or Housekeeping on Mars" —Andrew J. Haley, Past - President, American Rocket Society.
Ladies Night. Special Entertainment during the dinner hour.

This is not a complete list of all Section Meetings. It includes only those meetings for which we have received sufficient advance notice to permit listing.

Truck Panel Instruments Regrouped



New SAE Recommended Practice Differentiates Between Primary and Secondary Instruments and Controls

THE SAE Bus and Truck Technical Committee has recommended to manufacturers of trucks and tractor-trucks a new grouping for instruments, controls, and accessories. Here are the reasons for the recommendation:

1. To avoid confusing drivers when they shift from one type truck to another.
2. To promote safety and convenience.
3. To simplify design, production, and servicing.

The Recommended Practice, which was six years in the making, does not apply to commercial vehicles which use the clustered type instruments.

The relative positions of panel instruments that have been recommended are shown above. Design or dimensions are not specified.

Use Circular Type Instruments

The RP advises that all instruments should be individual, circular-type with symmetrical, clock-type dials, and with the center point of the calibration at the top of the dial. Only two sizes, "large" and "small," should be used.

Primary Instruments and Indicators

The instruments and indicators shown in Table I have been designated of primary importance to the safe operation of a vehicle. They are listed in the order of their importance and should be placed in the relative positions indicated in the diagram.

Primary Instrument Panel Controls

Table II shows the controls that are considered of primary importance. They are listed in order of importance and should be located in the relative positions indicated in the diagram.

Secondary Instruments or Indicators

The instruments or indicators shown in Table III are considered of secondary importance and are therefore not located in the diagram. Their location is optional with the builder or installer; but should not be so placed as to disturb the arrangement of primary instruments, indicators or controls.

Secondary Instrument Panel Controls and Accessories

Table IV shows the instrument panel controls and accessories that are considered of secondary importance and are therefore not located in the diagram. Their location and type is optional with the builder or installer; but should not be placed as to disturb the arrangement of primary instruments, indicators, or controls.

By grouping panel instruments and

Table I

Instrument and Alternative	Applicable to Engine Types			Size
	Gasoline	LPG	Diesel	
Air Reservoir pressure gage	X	X	X	Small
Vacuum reservoir gage	X	X	X	Small
Tachometer	X	X	X	Large
Speedometer-odometer	X	X	X	Large
*Lube oil pressure gage	X	X	X	Small
*Water temp. indicator	X	X	X	Small
Headlight beam indicator	X	X	X	*
*Ammeter (s)	X	X	X	Small
*Manifold vacuum gage	X	X		Small
Fuel pressure gage			X	Small
Fuel level gage	X		X	Small

* Indicator should be vertical to show normal condition

Table II

Control and Alternative	Applicable to Engine Type			Type
	Gasoline	LPG	Diesel	
Ignition switch	X	X		Pull-knob or key
Normal stop control			X	Pull-knob or T
Light switch (including panel lights)	X	X	X	Pull-knob
Starter button	X	X	X	Push-button
Choke	X	X		Pull-knob
Emergency stop control			X	Pull-knob, T or Loop
Throttle	X	X		Pull-knob
Starter lock			X	Key
Windshield wiper controls	X	X	X	Turning knob or lever
Manifold heater switch			X	Push-button
Manifold heater pump			X	Knob or T
Secondary fuel gage switch	X	X	X	Toggle switch
Secondary ammeter switch	X	X	X	Toggle switch

Table III

Instrument or Indicator	Applicable to Engine Types		
	Gasoline	LPG	Diesel
*Lube oil level gage	X	X	X
*Viscosimeter	X	X	X
*Transmission temp. gage	X	X	X
*Carrier temperature gage	X	X	X
Low oil-pressure indicator or light	X	X	X
Low air-pressure indicator or light	X	X	X
Air-brake chamber or application pressure gage	X	X	X
*Crankcase oil temp. gage	X	X	X

* Indicator should be vertical to show normal condition

Table IV

Control or Accessory	Applicable to Engine Types		
	Gasoline	LPG	Diesel
Marker & clearance light switch	X	X	X
Auxiliary marker switch	X	X	X
Heater control	X	X	X
Defroster control	X	X	X
Ash tray	X	X	X
Cigar lighter	X	X	X
Fog lights switch	X	X	X
Backing light switch	X	X	X
Manual radiator shutter control	X	X	X
Fuel pump primer			X
Auxiliary ignition switch	X	X	
Auxiliary starter switch	X	X	X
Battery disconnect	X	X	X
Windshield washer control	X	X	X
Circuit breaker resets	X	X	X

controls according to this recommended practice it will be possible to eliminate some mistakes by drivers. In an emergency his eyes and hands will always dart to the correct spot for the correct instrument. No matter what type of truck he drives, the standard panel will be compatible with his reflex habits.

Future work of this same Technical Committee will concern instrument sizes and their effect on operation, manufacturing, and maintenance.

New ASTM Standards On Petroleum Issued

THE latest edition of the ASTM Standards on Petroleum Products and Lubricants is now available. It was prepared by ASTM Committee D-2 on Petroleum and Lubricants, on which J. M. Campbell and J. C. Geniesse represent the SAE.

This recently released edition, which is dated November, 1954, gives in their latest approved form over 100 test methods, numerous specifications, and lists of definitions of terms relating to petroleum.

Appendixes cover proposed tests of jet fuels and aviation reciprocating-engine fuels.

Copies of this book are available from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. at $6.65 each for cloth cover and $6 for paper cover.

1955 SAE Handbook Goes Into the Mail

EARLY this month postmen began delivering the first 1955 SAE Handbooks to the 16,000 SAE members who indicated on their dues bills last fall that they wanted their free copy.

Mailing should be completed about the middle of the month.

Through better utilization of space, this year's edition contains more information in the same number of pages as last year's edition. Sixty-eight of the standards, recommended practices, and general information reports have been revised and 18 new ones added. The 1955 edition contains all current material approved for inclusion by the SAE Technical Board up to and including the Board's meeting in January of this year.

Some 19,500 copies of the 1955 SAE Handbook were printed. Copies are available to companies which employ SAE members at $10 each copy. Price to others is $20.

About SAE Members

continued from page 98

JOHN A. TUTTLE has moved to the Elliot Co., Jeannette, Pa., where he will be section engineer in the Development Engineering Department. Previous to this move, Tuttle was engineer with Cooper-Bessemer Corp., Mount Vernon, Ohio.

FRANK C. CODOLA is now a lecturer in drafting with City College of New York. He has been analytical engineer for Pratt & Whitney Aircraft Corp., East Hartford.

PHILIP L. WARD has been named manager of the turbine and control sales department, Solar Aircraft Co. He will promote sales of Solar's small gas turbine engines and of the company's control systems for aircraft engines.

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Leece-Neville Small Motors are produced for automotive use in 6 volt to 32 volt systems. Higher voltage motors are available for other applications. For full information, write The Leece-Neville Company, Fractional H. P. Motors Division, Cleveland 13, Ohio.

LLOYD B. LITTLE is in Washington, D. C. as special representative to the International Union of Operating Engineers. He will be acting for and under the direction of the general president of the International Union of Operating Engineers.

He had been serving as director of maintenance with Summit Fast Freight, Inc., Akron, Ohio.

HOWARD FELDMAN has taken a position with Hiller Helicopters, Inc., Palo Alto, Calif., as stress analyst. He had been structures engineer with McDonnell Aircraft Corp., St. Louis, Mo.

A. VERLE HAPTONSTALL has joined the Big Horn Coal Co. of Peter Kiewit Sons Co., Sheridan, Wyo. as mechanical engineer. His responsibilities will include the design and construction of a new coal tipple.

Haptonstall had formerly served as mechanical foreman for Peter Kiewit Sons, Omaha, Nebr.

ALEX PETROVSKY has joined Lockheed Aircraft Corp. Missile Systems Division, Van Nuys, Calif. as staff engineer. He had previously been section manager for W. L. Maxson Corp., New York City.

PIETER W. SCHIPPER, formerly vice-president and general manager of Douglas Tool Co., Hazel Park, Mich., has joined Howard Foundry Co., Milwaukee, Wis. in the position of general manager.

THOMAS J. PEARSALL has resigned from the Bureau of Ships, Navy Department, Washington, D. C. He is now employed as a project engineer with Continental Aviation and Engineering Corp., Detroit.

JOHN W. GROOMES is now senior project engineer for the Production Engineering Department, Allison Division, GMC. He had formerly served in the same position with Fisher Body Plant, GMC.

JOHN A. SCOTT has been elected president of Sinclair Chemicals, Inc., New York City. He also serves as a director of Sinclair Research Laboratories and is a director of Calumet Nitrogen Products Co. He had been executive vice-president of Sinclair Chemicals and manager of the Petrochemicals Division.

MAURICE H. SATCHELL has become senior combustion development engineer with Orenda Engines, Ltd., formerly A. V. Roe, Canada, Ltd. He had served as ignition systems engineer.

GEORGE B. SWANSON is now associated with Consolidated Vultee Aircraft Co., Division of General Dynamics Corp., as design engineer. He had been tool engineer for Solar Aircraft Co.

HERBERT A. STANELAND has joined Canadian Arsenals, Ltd. of Toronto, Ont., Canada as mechanical engineer in the Radar Division. He will be responsible for the design of mechanical components of radar equipment, such as antennas and rotating frames. His work for the Master of Science degree at the Massachusetts Institute of Technology has been completed.

KENNETH C. ENGEL, formerly rocket engineer with Bell Aircraft Corp., Buffalo, N. Y., has become associated with Aircraft Engine Division of Ford Motor Co. as product test engineer.

NOAH A. SHEALY is now associated with Clark Equipment Co. Transmission Division, Jackson, Mich. in the position of project engineer. He had been designer for the Products Development Laboratory, Borg-Warner Corp.

RUSSELL H. KENT, JR., who has been serving as development engineer with Sun Oil Co., Marcus Hook, Pa., has taken a position with Campbell Soup Co., Camden, N. J., as design engineer.

JOHN L. WANTLAND has joined Carbide and Carbon Chemicals Co., Oak Ridge, Tenn. as development engineer. He had been propulsion engineer for Fort Worth Division of Convair Division, General Dynamics Corp.

JOHN B. THEURER is now associated with L. A. B. Corp. of Skaneateles, N. Y. as experimental test engineer. He has been with Bendix-Westinghouse Automotive Air Brake Co. in the position of tester.

R. R. HIGGINBOTHAM, as chief power plant engineer of Republic Aviation Corp., has been placed in charge of power plant design on all projects. He has been serving as chief power plant engineer since 1943.

ARMAND BOSCO has joined AiResearch Mfg. Co., Los Angeles, as a development engineer to work on turbine engines. He had been project engineer for Aircooled Motors, Inc., in Syracuse.

CLAUDE W. HESS has taken a position as design engineer with Hiller Helicopters, Inc., Palo Alto, Calif. Previous to this move, he served as associate engineer for Douglas Aircraft Co., Inc. in Long Beach, Calif.

SIDNEY H. WEBSTER has been appointed manager of the Los Angeles office of Jack & Heintz, Inc., Cleveland. He will supervise sales and service activities with all military and commercial aircraft customers on the West Coast, excepting those in the State of Washington which are handled by the company's Seattle office.

Webster has headed the company's New York office for the past two years.

JOHN H. ALLMAND is now associated with the Hood Sponge Rubber Co., Chicago, as sales engineer in the Detroit office. Formerly he served as liaison engineer, special assignment, with Kaiser Motors Corp.

GEORGE TSAKALOS is now with Lycoming Division, Avco Mfg. Corp., Stratford, Conn., as a test development technician in gas turbines and components. He has been foreman, aircraft engine overhaul, Pacific Airmotive Corp., Linden, N. J.

JAMES A. HILGENDORF is now associated with Thompson Products, Inc., Special Products Division in Cleveland as design engineer. He had served with John Deere Waterloo Tractor Works as junior engineer in the research division.

WALTER E. ROGERS is now associated with Michigan Leather Products Co., Detroit, as oil seal designer. He had been serving in design layout, Research & Development Section, GMC Chevrolet Central Office.

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SENSATIONAL LOW PRICE ON NEW L-N ALTERNATOR SYSTEM
The new Leece-Neville Alternator brings to fleets of passenger cars, light and medium trucks all the famous advantages that larger L-N Alternators have proved by performance for over nine years: charging current with engine idling, high output, low maintenance cost. Plus new, simplified bracketing. Yet the new L-N Alternator System actually costs less than "extra" output d. c. generators.
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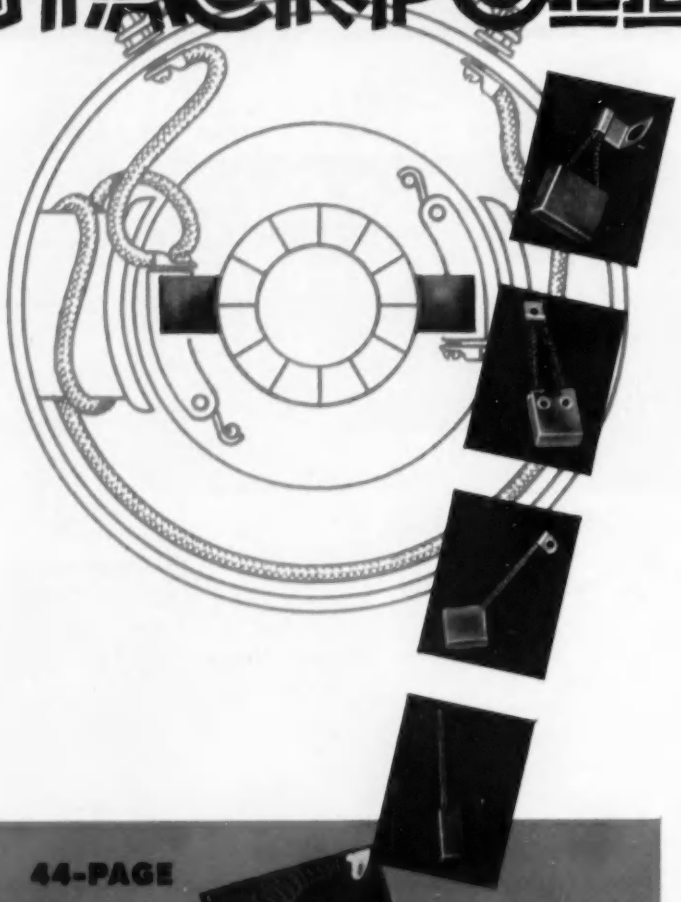

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SP News About SAE Special Publications

JET TRANSPORTS really hit the news recently when Trans-Canada Air Lines put the Vickers Viscount into regular operations—the first jet in commercial use on this continent. Other airlines will soon follow suit.

Engineering for these jets is moving at an accelerated pace. **To give you a picture of where it's headed, SAE has just issued a symposium called "What's Ahead in Engineering for Jet Transports."**

Contributing to this eight-paper package are some of the leading airline, airframe, and gas turbine engineers. They take a hard look at the economics of jet transports and the jet fuel situation.

If you're an SAE member, you can get a copy of this symposium for $2.50. Non-members will be charged $5.00. The report is listed as SP-129.

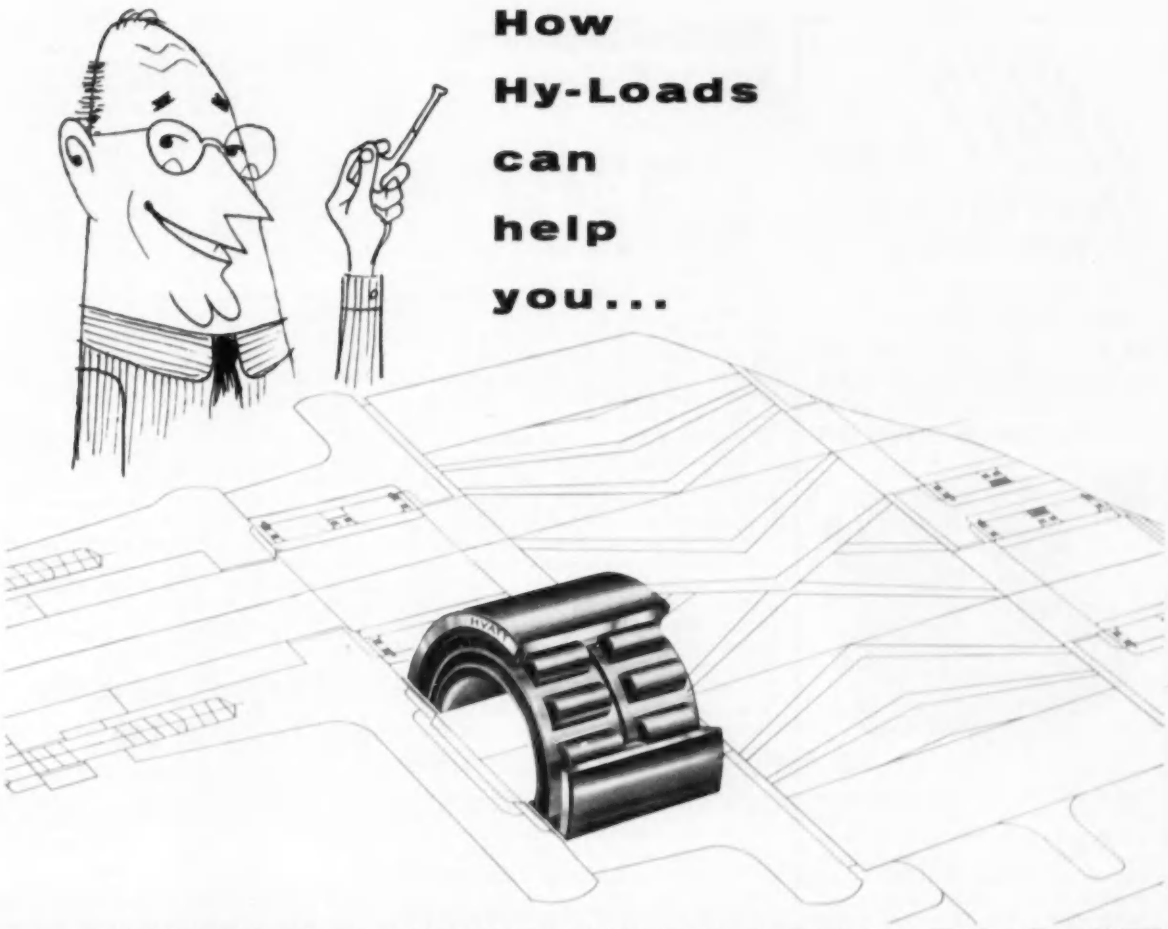
JOURNAL AND TRANSACTIONS REPRINTS: SAE can furnish you with reprints of Journal and Transaction articles **if you want quantity lots.** Minimum acceptable reprint order is 100 copies.

Prices for individual articles and desired quantities will be furnished upon request. Just to give you an idea of what the charges are . . . 100 copies of an article reproduced as a four-page booklet are priced at $20. Each additional hundred will cost you $2.60.

JUST OUT—**Engineering Know-How in Engine Design, Part III.** You can now order the third in a series on engine design as practiced today.

Here is a product that reflects today's design and development practices of leading automotive and engine company engineering departments . . . the kind of stuff you won't find in textbooks. For example, you'll find in this report, SP-137, such information as: **materials in engine design . . . reciprocating engine dynamics . . . applying gasoline and diesel fuels . . . light two-cycle engines . . . the outboard motor . . . design features of an opposed piston diesel.**

This report is another tribute to the SAE Milwaukee Section, out of whose lecture series program it grew. You can order a copy now. Price: $3.00 to SAE members, $6.00 to nonmembers.



How Hy-Loads can help you...

PROVIDE HORIZONTAL FLOAT

HY POTENUSE, the sage of the slide rule, SAYS:

Ever have herringbone gears bind on you because the shaft couldn't float freely to permit the gears to mate properly? It can happen when you use laterally locked bearings—*but it can't happen here!*

The designer of this pump assembly has made doubly durn sure *he* won't get into trouble—by specifying HYATT A-6200-T Cylindrical Roller Bearings. *First*, he knows they'll provide plenty of lateral float so the herringbone gears can mesh freely (and to take care of possible shaft expansion in case hot liquids are pumped). *Second*, a single bearing with two rows of rollers gives him maximum load capacity in minimum space—without any possibility of overload on one bearing or the other that might creep in if he used two separate bearings.

If you haven't a HYATT General Catalog No. 150 handy, better send for yours pronto, brother—it'll save you a heap of time and headaches! *Remember, you can't go awry when you specify—*

your COMPLETE LINE of cylindrical roller bearings

HYATT ROLLER BEARINGS

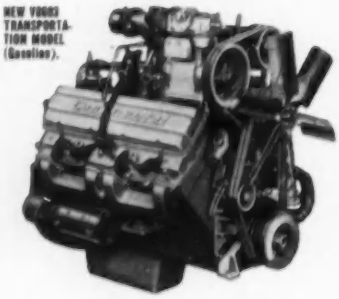
STRAIGHT BARREL TAPER

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

NOW from CONTINENTAL MOTORS

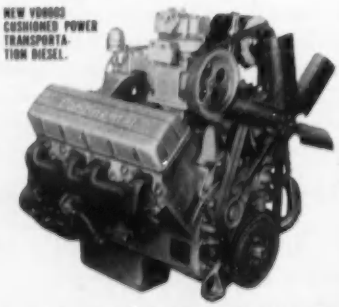
... A BRAND NEW AND OUTSTANDING "FAMILY" OF HIGH-SPEED HEAVY-DUTY V8 ENGINES . . . GASOLINE AND CUSHIONED® POWER DIESEL . . . FOR A WIDE RANGE OF TRANSPORTATION, INDUSTRIAL AND MARINE USES

NEW V8603 TRANSPORTATION MODEL (Gasoline).



Latest and most notable addition to a line of internal combustion power plants famed for dependability ever since 1902 is this completely new "family" of rugged V8's which Continental Motors recently introduced. These 603 Series Overhead Valve Red Seals—a 240-h.p. gasoline version, the V8603, and VD8603 Cushioned Power Diesel developing 182 h.p. at 2800 r.p.m.—tap a deep reservoir of engineering and production experience and reflect specialized skills acquired over a period of more than 50 years.

NEW VD8603 CUSHIONED POWER TRANSPORTATION DIESEL.



WRITE TO MUSKEGON FOR DETAILED INFORMATION

Continental Motors Corporation

MUSKEGON AND DETROIT

1905 GOLDEN ANNIVERSARY 1955

Industrial Engineering Vital to Production

Based on paper by

DAN NETTESHEIM

The Heil Co.

INDUSTRIAL Engineering is the department deciding where, how, when, what, and why; Manufacturing then decides who. But that's only the beginning. From the very inception of the product, the industrial engineers must coordinate their work with the product engineers to help make quality products at optimum cost.

Design and production coordination is helped if the design department is placed in the production area. One company found great benefits from setting up Manufacturing Project Engineering in its Industrial Engineering with final authority in each division. One man acts as coordinator and clears all changes.

Most companies agree that manufacturing departments can do their job more easily if they use the Industrial Engineering Department in the way intended. An example would be Industrial Engineering's use of predetermined times to build standard times for an incentive system or measured day rate system.

The more information at the disposal of an Industrial Engineering Department the more help it can be to Manufacturing and other departments. It should have a weekly report by department and subdivided by foremen, giving a breakdown of manhours expended in all categories, such reports to include idle time, down time, productive time, and the like. With this information going to the supervisory force while fresh, cures can be made promptly.

Preproduction estimating is invaluable for the Industrial Engineering Department. Such estimates are usually closer to reality because the person estimating is fully familiar with each phase of cost. Also, the estimates and accompanying information indicate in advance any special requirements. When this is passed on, the information is filed as a future warning.

Other information of value are maintenance data which will permit the setting up of a consistent replacement system for all equipment in a plant, and a yearly listing of all tools and equipment by acquisition date.

(This article is based on the secretary's report of Panel on Production held as part of National Tractor Meeting and Production Forum, Milwaukee, Sept. 13, 1954. It is available in full in multilith form together with the reports of the other six panels as SP-308 from SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.)

Production Panel Members . . .

C. E. Verkler,
Panel Leader
Caterpillar Tractor Co.

D. R. Nettesheim,
Panel Secretary
The Heil Co.

Martin Fahey,
Allis-Chalmers Mfg. Co.

L. B. Harris,
L. B. Harris & Assoc.

Wm. Piersen,
Allis-Chalmers Mfg. Co.

D. Sherman,
A. O. Smith Co.

D. D. Wheeler,
Ionia Mfg. Co.

O. Wieseman,
Caterpillar Tractor Co.

International Harvester Has Fine New Lab

Based on paper by

PAUL T. BRANTINGHAM

Motor Truck Division, International Harvester Co.

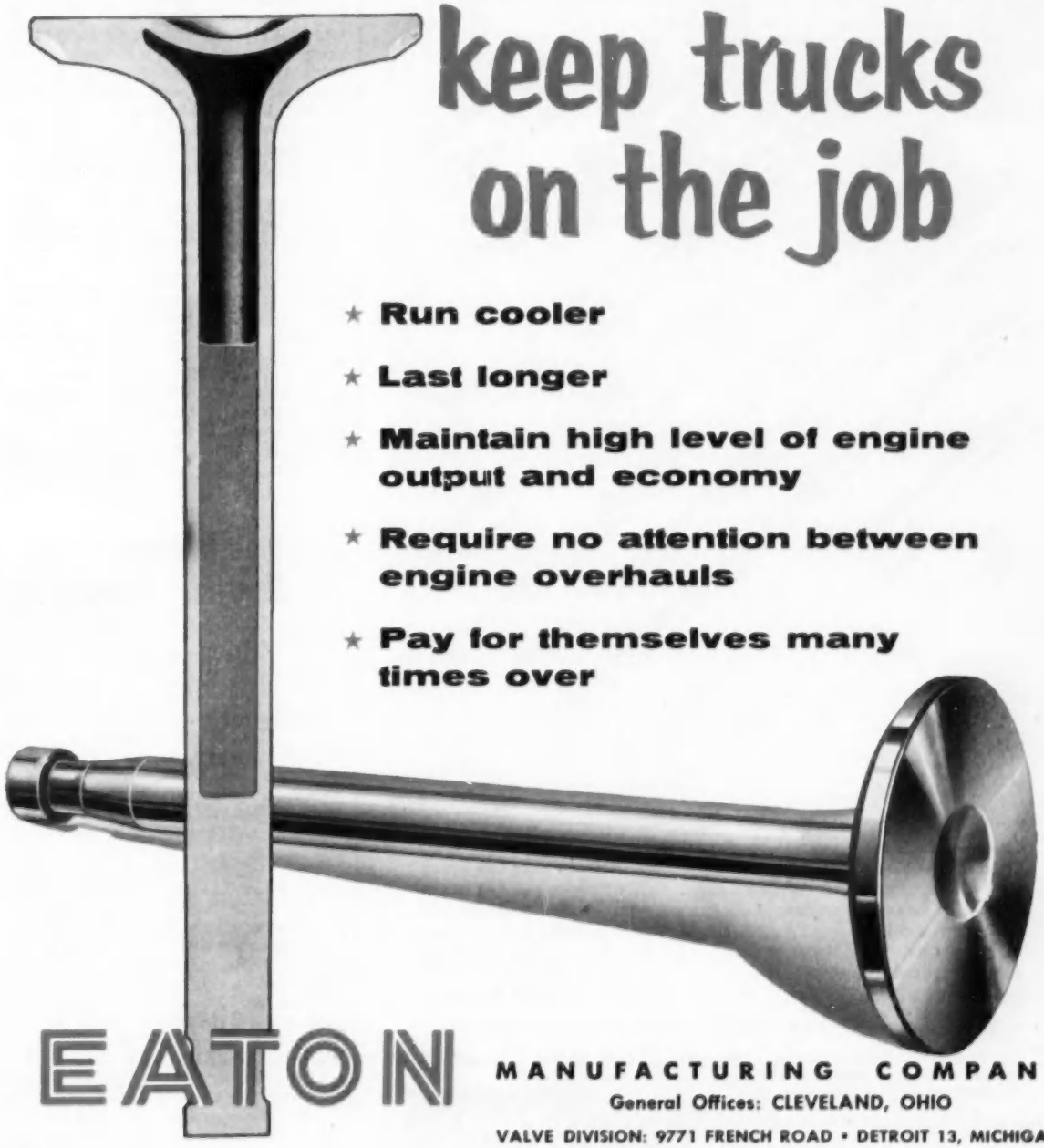
THE stress laboratory in International Harvester's new engineering facility for truck design and development has temperature and humidity control to insure accuracy in delicate measurements. It is also equipped with a bed plate capable of taking the heaviest truck chassis with loads.

A separate spray booth is provided for applying brittle lacquer coatings used in stress analysis. This is equipped with a separate high capacity ventilating system for removal of the toxic fumes.

The fatigue laboratory covers 7092 sq ft and is provided with 110-v, 220-v, and 440-v ac, 230-v dc, air pressure at 90 psi, water, and drains. These services are so fixed as to be readily available within a 10-ft radius of any location in the room. Access holes to a system of subsurface trenches make this possible.

Test fixtures involving impact or vibration loading are mounted on a 120-ft bed plate set on a foundation of concrete, sand, and cork to minimize transmission of vibration to the building. (Paper "A New Engineering Facility for the Design and Development of Improved Motor Truck Transportation" was presented at SAE National Transportation Meeting, Boston, Oct. 19, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Eaton SODIUM COOLED VALVES keep trucks on the job



- ★ Run cooler
- ★ Last longer
- ★ Maintain high level of engine output and economy
- ★ Require no attention between engine overhauls
- ★ Pay for themselves many times over

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PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

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BELLWOOD, ILLINOIS
Established 1872

Navy BuShips Seeks Better Diesel Engines

Based on paper by

REAR ADMIRAL W. D. LEGGETT, JR. USN
Chief, Bureau of Ships.

INCREASED supercharging of four-cycle engines, turbocharging of the two-cycle, and heavier fuels, appear to offer the greatest chance for increasing the power and lowering the cost of today's diesel engines. We need engines which are lighter and more compact, which have a lower first cost and reduced operating cost. I am well aware that many of these things are in conflict, but that's what we have engineers for.

Simplicity and ruggedness are great needs. We must try to insure that the equipment we have placed in our ships, or have under development, can be depended upon fully in peace and war. We are proceeding in our new ship designs with the idea that we will be prepared to make the best possible use of these engines if another war should come, rather than making extemporaneous installations of them in our escort and amphibious craft. (Paper "Some Future Diesel Possibilities" was presented at SAE National Diesel Engine Meeting, Cleveland, Oct. 26, 1954.)

Develops Method For Studying Scavenging

Based on paper by

W. H. PERCIVAL
General Motors Corp.

Complete paper will appear in 1955 SAE Transactions

THE pitot sphere appears to be the most satisfactory instrument for static-method study of air flow through a cylinder of a two-stroke diesel engine.

The instrument head is a brass hemisphere 0.10 in. in diameter supported at the rear by a gooseneck arrangement which permits it to be inserted through a 0.20-in. opening. One 0.008-in. hole is drilled in the center while four holes each are drilled approximately 42 deg from the center hole, two in the plane of the support shaft and two at 90 deg from this plane. These five holes lead to five 0.020-in. OD by 0.014-in. ID brass tubes which transmit the pressure and serve as the support for the hemisphere. These five tubes are soldered into five 0.032-in. brass tubes which lead up the 0.156-in. steel support shaft. At the top are five radial tubes to which are attached the manometer connections using 1/16-in. surgical tubing.

The pitot sphere has three advan-

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The many new developments and steady progress evidenced by WIX make this company an attractive source for both fuel and lube oil filters and cartridges of every size and filtration principle. WIX has years of successful O.E.M. experience with important companies. Alert management, sound financial structure, fine earning record, abundant capacity . . . imaginative, cooperative engineering and merchandising.

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...wouldn't get to first base

Don't blindfold yourself to your own future. Know where you want to go, and you'll see how much better the opportunities are at Fairchild.

Engineers with an eye on their futures are looking to Fairchild for careers that lead to the top, because they know at Fairchild they'll work in the country's most advanced and active research centers. They'll be in right from the beginning on everything new that's happening in aviation.

Fairchild is looking now for experienced aerodynamists and designers. The right, wide-awake men will find unparalleled opportunity to move straight ahead as fast as their abilities let them.

Put yourself in a position with a future – at Fairchild. Send your resume today to Walter Tydon, Chief Engineer.

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FAIRCHILD
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"where the future is measured in light-years"

tages over other point flow measuring devices:

1. It can be calibrated in a low-turbulence wind tunnel and then used inside a cylinder where the turbulence intensity is high without appreciable error.

2. The error due to transverse flow along the support shaft is negligible.

3. The error when traversing through a steep velocity gradient is not serious because of the small diameter. This is the major error and results in an apparent increase in flow through the cylinder. Integration of the velocity profile gives a 2 to 4% increase over the actual flow measured by an orifice meter. In a typical cylinder the difference in velocity across the 0.10-in. diameter sphere can amount to 8 fps, with the flow angle changing as much as 10 deg.

(Paper "Method of Scavenging Analysis for Two-Cycle Diesel Cylinders" was presented at SAE National Diesel Engine Meeting, Cleveland, Oct. 26, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

New Starting Fuels Excel Di-ethyl Ether

Based on paper by

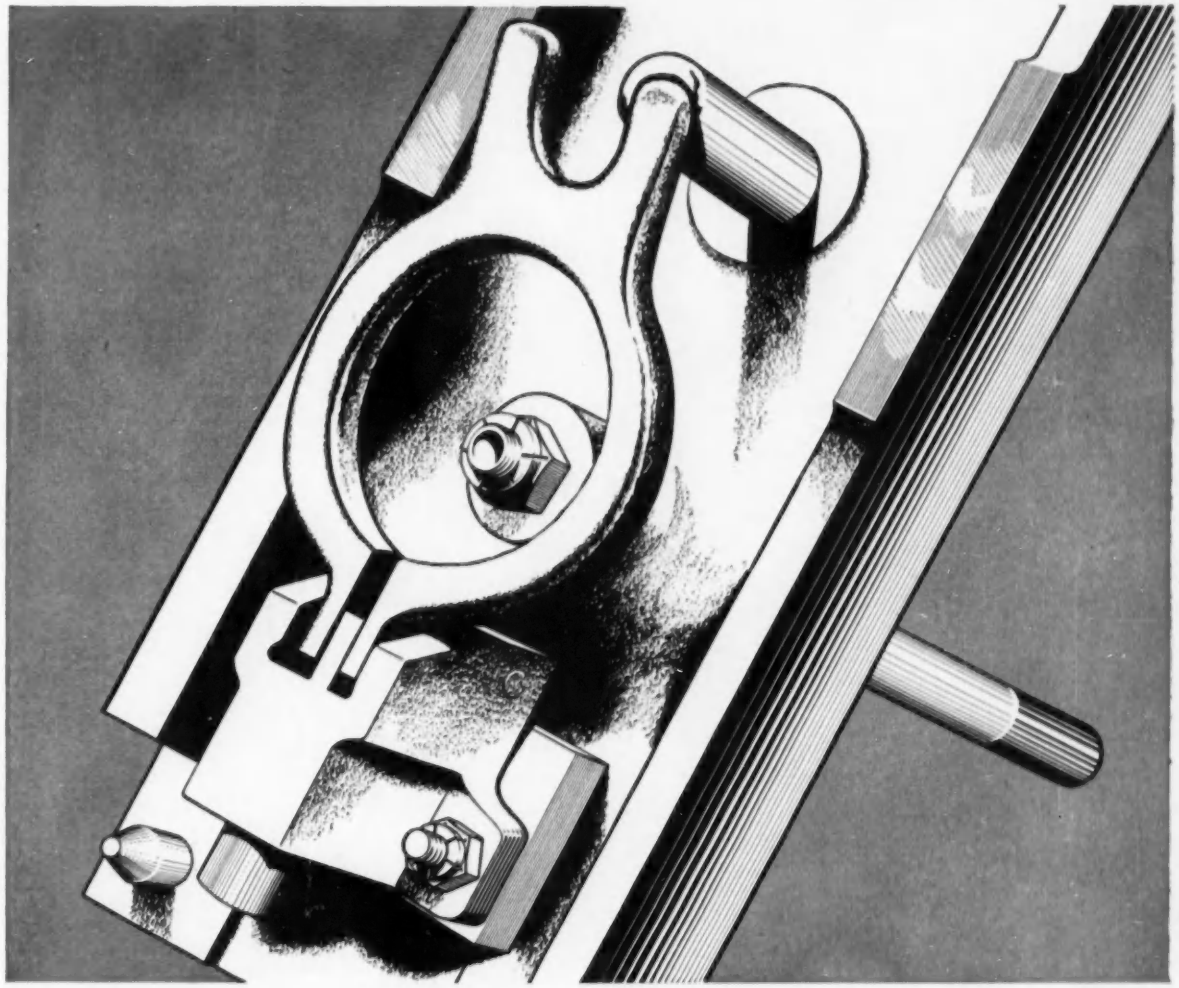
W. G. AINSLEY
and
H. D. YOUNG
Sinclair Research Laboratories, Inc.

ONE of the most effective compounds for kindling a fire in a diesel cylinder at low temperatures is di-ethyl ether, but in certain respects the very sensitivity of the straight compound to auto-ignition under low temperatures and pressures is a disadvantage to its use as a starting aid.

Recognizing di-ethyl ether's limitations, exploratory studies were undertaken to seek a material or combination of materials which would have all the advantages of di-ethyl ether and none of its disadvantages. Several promising fluids resulted. Two, which are in field use, contain relatively small percentages of di-ethyl ether. The di-ethyl ether serves as a carrier for the other blend compounds, which are effective starting aids in their own right, and more important to trigger rapid ignition of these blend compounds.

The combustion characteristics of these fluids are such that after ignition they burn without excessively rapid rates of pressure rise or severe detonation. Low temperature and pressure response is good. The fluids lend

FLEXLOC AT WORK



MORE AND MORE FLEXLOC LOCKNUTS are being used on assemblies where dependable locking is essential to the operating efficiency of the equipment. This stationary spindle is a good example of the difficult jobs FLEXLOC locknuts are doing throughout industry.

FLEXLOCS were put on this unit after a number of other locknuts had failed to keep the spindles tight. Even the high humidity, extreme vibration, and presence of lint and grease have not loosened the FLEXLOCS.

FLEXLOC Self-Locking Nuts—one piece, all metal—are available in a full range of sizes in any quantity. Standard FLEXLOCS are stocked by leading industrial distributors everywhere. Write for Bulletin 866 and samples. STANDARD PRESSED STEEL CO., Jenkintown 55, Pa.

DO YOU KNOW? Standard FLEXLOCS smooth off rough bolt threads. The locking threads on all-metal FLEXLOCS are not chewed up when used on rough bolts.

Standard FLEXLOCS lock securely on bolts varying in diameter tolerances. The all-metal, resilient locking sections of the nut accommodate themselves to the diameter tolerances.

Standard FLEXLOCS are one piece, all metal. They are not affected by temperatures to 550°F. Nuts lacking these features have a more restricted temperature range.

Standard FLEXLOCS lock securely—stopped or seated—when 1½ threads of a standard bolt are past the top of the nut.

Standard FLEXLOCS are not affected by moisture, oil, dirt or grit. They lock efficiently under all conditions, regardless of the vibration encountered.

FLEXLOC®
LOCKNUT DIVISION
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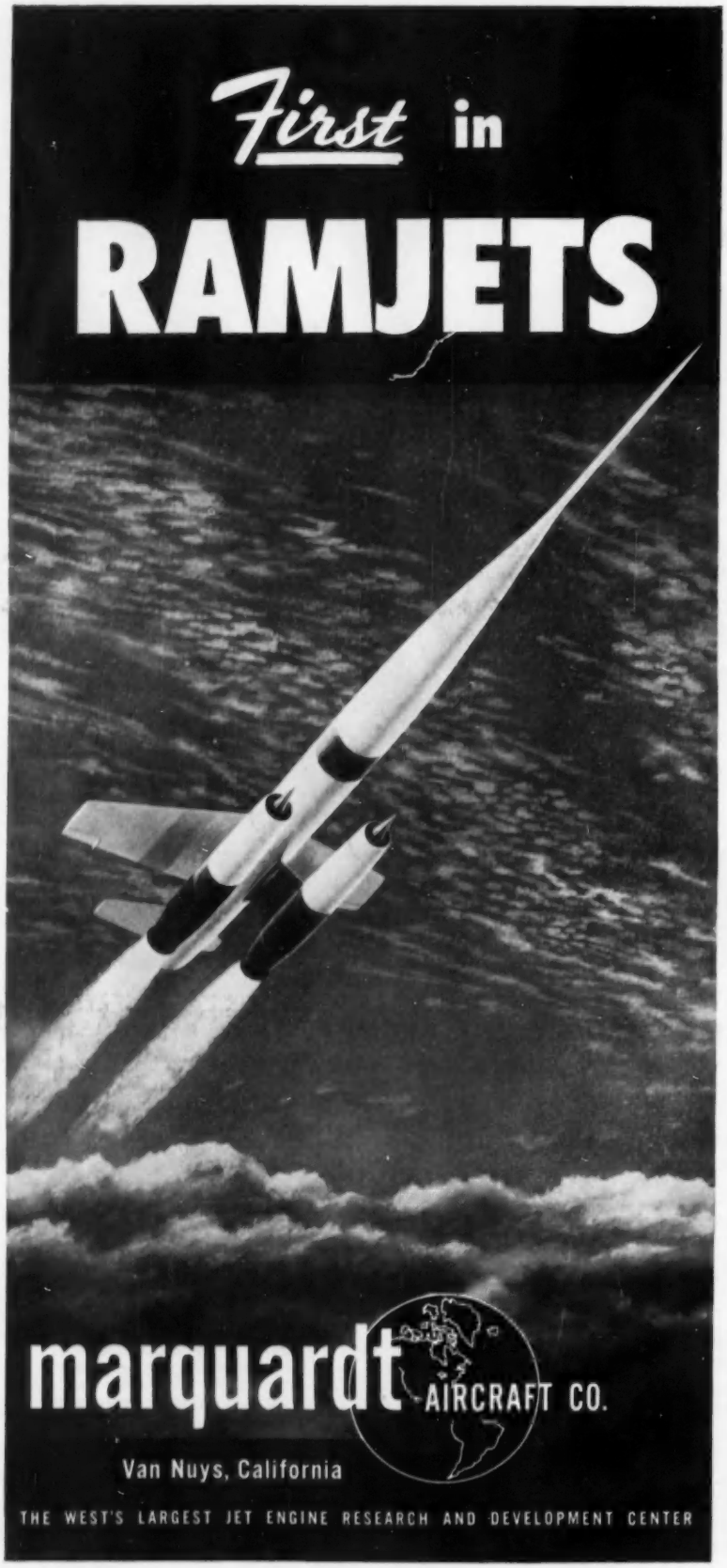
JENKINTOWN PENNSYLVANIA



themselves well to manifold application, with the proper technique; and handling hazard has been minimized.

Throughout these studies on fluids, application was found to be the predominant factor in starting. Failure of inexperienced operators to gage fluid requirements is probably the major cause for failure. Success, therefore, requires that the knowledge of cold engine starting be built into some device. Accordingly, a vari-flow engine starter, a pressurized, closed-circuit device, was designed which has proved effective for its designed purpose, easy to use without prior experience, and adaptable for use on a wide variety of engines. (Paper "Application of Starting Fluids to Internal Combustion Engines" was presented at SAE National Diesel Engine Meeting, Cleveland, Oct. 26, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Diesel Cranking Studied At Arctic Temperatures

Based on paper by

JAMES F. BLOSE
J. P. QUALEY
J. T. DUCK
and
L. G. SCHNEIDER
U. S. Naval Engineering Experiment Station

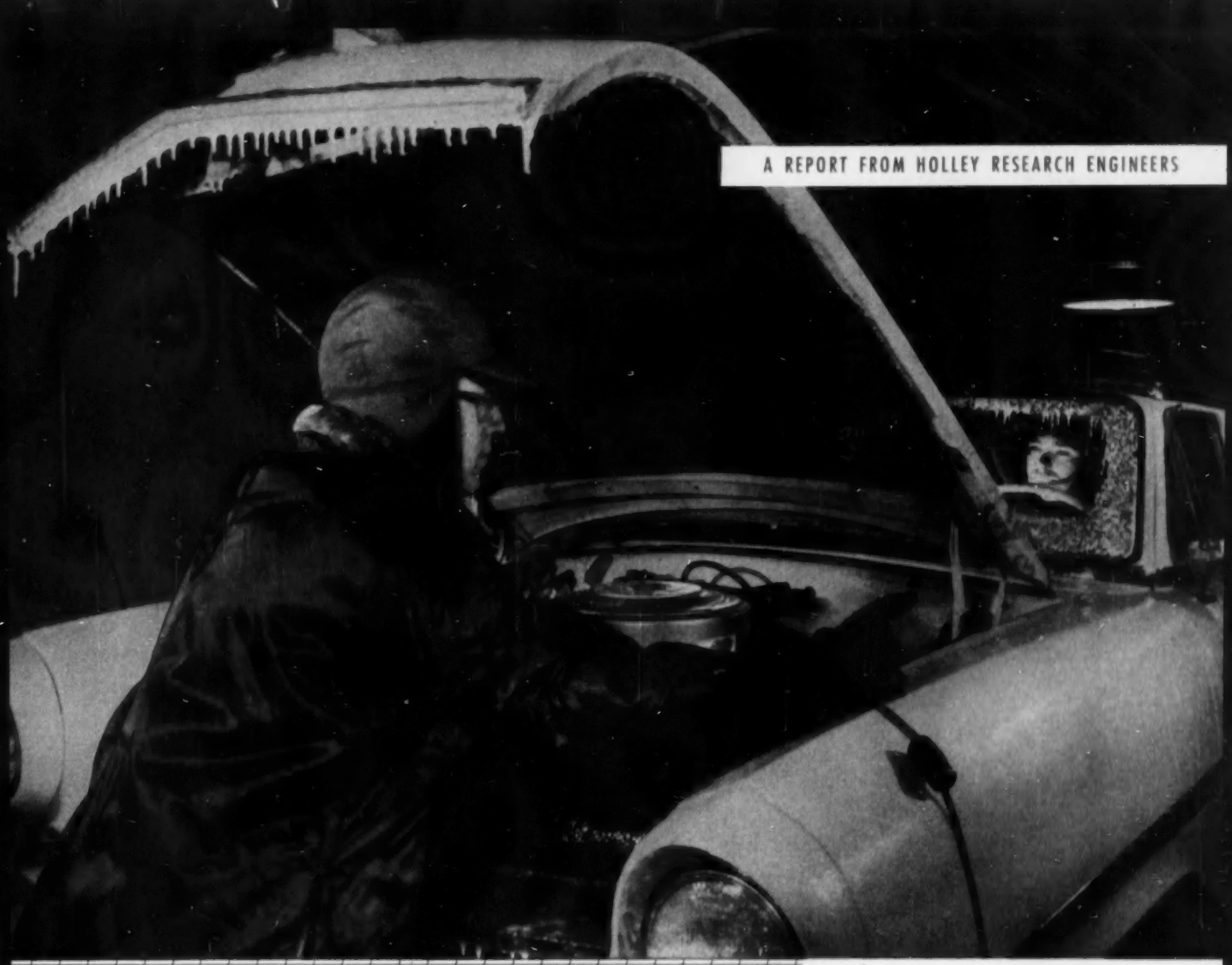
STARTING aids and cranking systems for diesel engines are not constant in their relative effectiveness. Any aid may give some improvement, but the best can be determined only by trial and error. The difference in performance between the best and the poorest may be of the order of 20 to 30 F.

Electric air intake heaters have lost ground to flame primers, presumably because the latter use little current and impose less load on the battery. Glow plugs are used infrequently. Being connected in series, when one failed they all failed and they require a relatively heavy current at low voltage. A new type comprising a fine wire heating coil in a thin protecting steel sleeve is connected in parallel. Using these glow plugs with a four-stroke-cycle, precombustion-chamber-type engine having an unaided starting temperature of 58 F, starting was effected at −18 F. With an ether-fluid-type starting aid without glow plugs, the same engine was started at −20 F.

Starting performance of most engines can be improved by using 24 to 30-v cranking systems instead of 12 to 24-v. No cranking system was fully satisfactory since those giving highest cranking speeds and ease of charge at low temperatures provided only short duration cranking before exhaustion.

The findings from tests to determine

A REPORT FROM HOLLEY RESEARCH ENGINEERS



How Holley engineers measure "cold start" time to a tenth of an icy second

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The Holley Cold Room test is just one of many successive research steps that each new carburetor or fuel metering device undergoes. Many prototypes are discarded before they ever reach the Cold Room testing stage. Those that do show merit get a rigorous test - - at 20° below zero - - of initial start time, rate of warm-up and operation during warm-up, and cold weather operation at normal engine temperatures.

Out of such exacting tests like the Holley Cold Room and Holley's continuous program of planning, designing and rebuilding, will emerge the carburetors and fuel metering systems for the cars and trucks of tomorrow.

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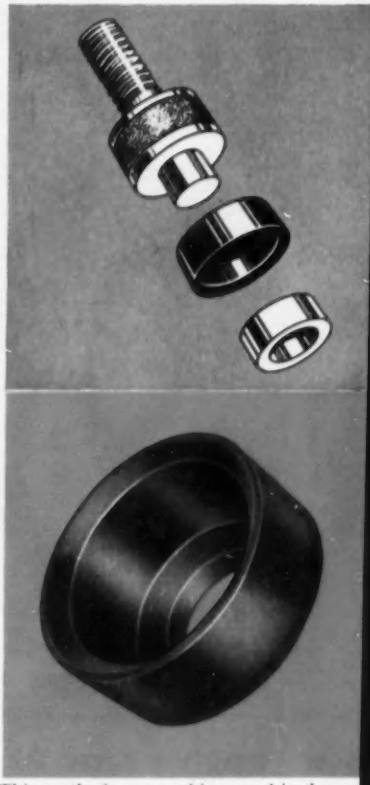

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the effect of oil viscosity on cranking requirements were as follows:

- Oil viscosity is the major factor in low-temperature cranking requirements of a diesel engine.
- Shearing of the oil film causes a significant increase in temperatures in the bearing area and to a lesser extent on cylinder wall surface.
- No significant change in crankcase temperature occurs during normal cranking periods.
- A rapid decrease in torque during the first minute of cranking appears associated with viscosity changes resulting from increased temperatures.
- Breakaway torque does not change apreciably with oil viscosity or temperature.
- Oil flow is restricted by high viscosity. Little or no flow occurs below the pour point.

(Paper "Effect of Low Ambient Temperature on Cranking and Starting of Diesel Engines" was presented at SAE National Diesel Engine Meeting, Cleveland, Oct. 26, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on discussion . . .

W. E. Meyer
The Pennsylvania State University

At Penn State we have made similar tests but in these the major variable was the engine rather than oil viscosity. We have tested 11 different gasoline and diesel engines using an arctic oil. We have found an empirical formula which enables one to predict the cranking torque at extremely low temperatures from the measured torque at some high temperature. The same constants may be used for all engines which we tested as long as we distinguish between gasoline and diesel. The formula will not predict exact values but it should serve to eliminate a lot of guesswork.

New OHV Engines Create Wear Problem

Based on paper by

ARTHUR M. BRENNEKE
and
M. E. ESTEY
The Perfect Circle Corp.

THE new large bore, short stroke OHV, V-8 engines represent a very satisfactory net gain over old designs as regards effective life or initial overhaul period, but they appear to be more

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subject to corrosive wear than the older ones.

Slow warm-up and poor heater performance may afford a clue to the cause of this wear. Tabulations of warm-up time and block water capacities of the new engines as compared with those they replaced show an increase in both items.

Another factor making for higher ring and cylinder wear is the almost universal use of 5/64 in. width compression rings in current engines. Assuming the ring width versus wear relation for corrosive wear to be the same for abrasive wear, then wear rates with 5/64 in. compression rings could be expected to be 20% higher than for older engines using 3/32 in. rings. Space considerations make use of wider compression rings unlikely. Materials of still lower wear rate than chromium plate will have to be developed for rings. Such materials are known, but not yet in sight commercially.

New designs and constructions affecting drastic reductions in cooling capacities are in early development stages. Refinement of thermostatic controls and by-pass systems can also be expected and they should afford considerable improvement.

The limited data available seems to point in the direction of increasing oil consumption to reduce wear. This prescription won't be popular. Actually, the magnitude of the difference is such that the matter is of more academic than practical importance. (Paper, "Piston Ring and Cylinder Wear—An Appraisal of Current Problems" was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 5, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

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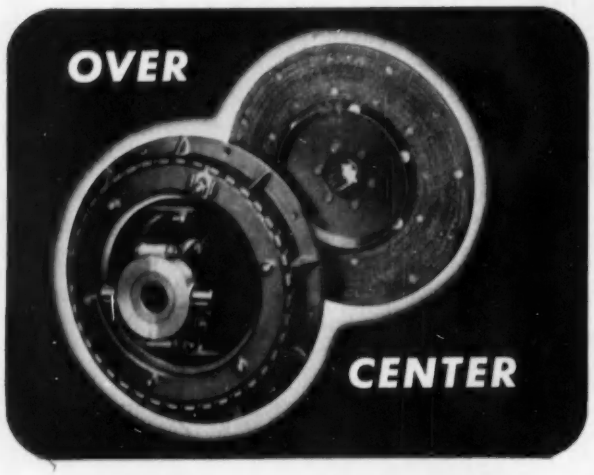

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CLUTCHES

Arctic Oil Given Cranking Test

Based on paper by

W. E. MEYER
J. J. DeCAROLIS
The Pennsylvania State University

and

R. L. STANLEY
Diesel Engine Manufacturers Association

Complete paper will appear in 1955 SAE Transactions

LUBRICATING oil developed to meet military specifications MIL-O-10295, which prescribes a pour point of −65 F and kinematic viscosities of not more than 8500 centistokes at −40 F and not less than 5.75 centistokes at 210 F, has now been given a cranking test with 11 different gasoline and diesel engines. Here briefly, the results are summarized:

1. Breakaway torque is always less than the initial cranking torque after steady speed has been reached.

2. At 0 F there is very little change of torque with time, but at −65 F the torque curves show a considerable negative slope during the first few seconds of cranking.

3. The general character of the torque versus temperature curves is fairly constant for all engines.

4. Cranking speed has relatively little influence on torque after 8 sec. The general trend is toward an increase with speed.

5. Equilibrium torque at −65 F de-

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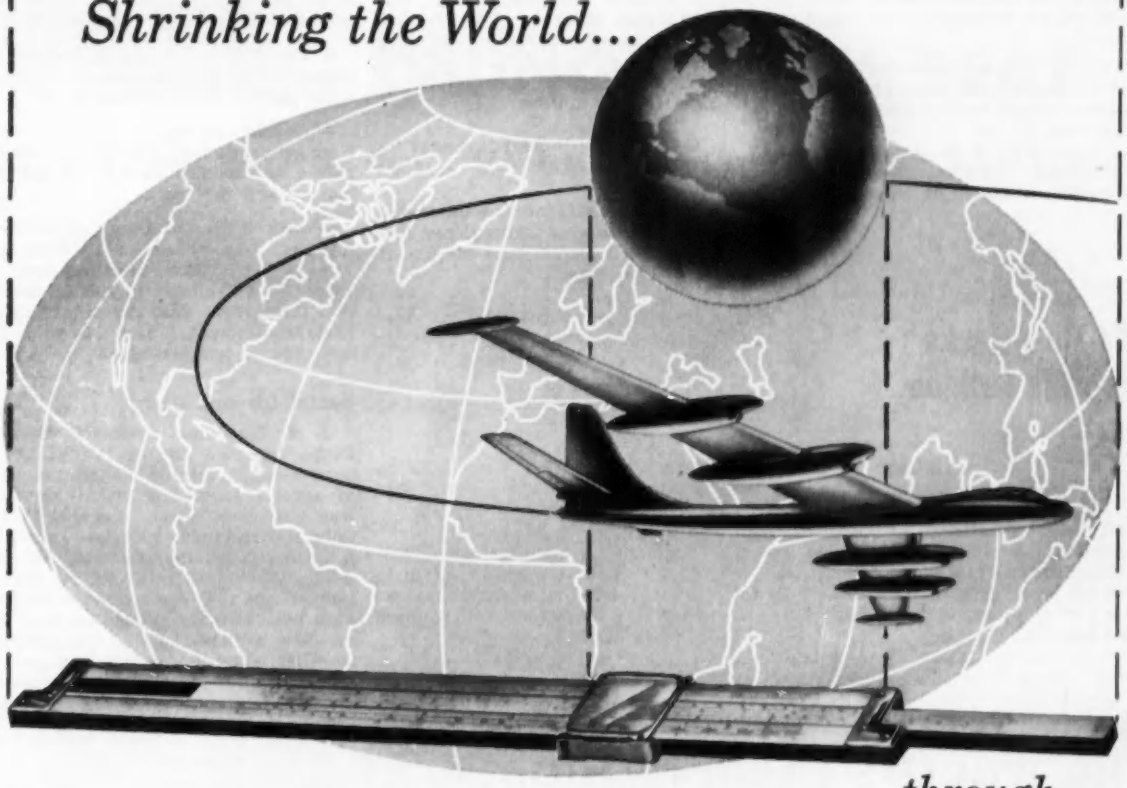

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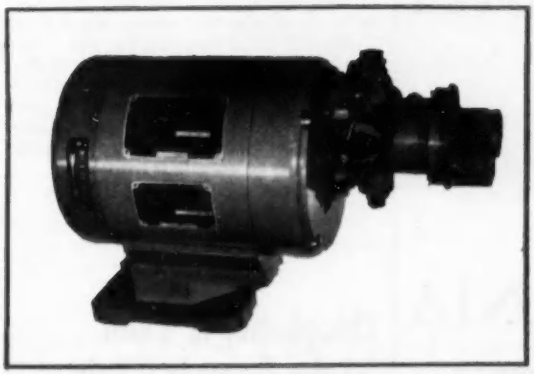

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creases as the cranking speed is increased and exhibits greater variations from engine to engine than the 8 sec torque.

(Paper "Engine Cranking at Arctic Temperatures" was presented at SAE National Diesel Engine Meeting, Cleveland, Oct. 26, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Martin Attacks Aircraft Fatigue

Based on paper by

A. J. KULLAS
The Glenn L. Martin Co.

THE failure of aircraft primary structural members due to fatigue has increased significantly in the last decade. Records make it plain that such failures can no longer be termed sporadic, and ignored.

With the intent of ferreting out potential fatigue troubles, Martin has evolved a plan of attack of which some phases are already being applied fully and others are just being started. The chronological application is envisioned in nine steps as follows:

1. Establish a life goal in hours for each model.

2. Study and evaluate the important effects of speed, wing loading, load factor, and altitude on fatigue life during preliminary design.

3. Provide extra material on specific components where life calculations indicate the need.

4. Apply detail design rules based on past experience.

5. Conduct repeated load tests to check the stress-number (S-N) data used in life calculations.

6. Acquire data on the service history of the model during operation to support the related assumptions on frequency and magnitude of loads used in life calculations.

7. Review and possibly revise the aircraft in the light of data from repeated load tests and service history.

8. Establish the where and when of inspection during operation in order to apply preventive maintenance.

9. Obtain and repeat-load test parts from service to help develop and establish a method of correlating service history and S-N data.

(Paper "A Plan of Attack on Aircraft Fatigue" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 9, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on discussion . . .

E. H. Spaulding, Lockheed Aircraft Corp., reported the big difficulty in conducting a fatigue testing program of several specimens was in getting the specimens made. Lockheed uses only one specimen which is tested to a predicted loading spectrum for the design mission of the airplane. Kullas pointed out that the spectrum method does not cover the possibility that individual airplanes would be assigned to other types of missions, and he felt that a basic S-N curve must be established so that data are easily adaptable to different types of missions.

William Littlewood, American Airlines, Inc., pleaded for the collecting of more fatigue experience from actual service, citing as an example that preliminary NACA data shows short-haul transport operations giving five times the fatigue damage of average operations. The airlines, he said, want inspectability, easy replaceability, and the getting away from designs where the failure of a single part would result in loss of structural integrity.

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Thiophenol is Chief Intake Deposit Villain

Based on paper by

C. R. BAUER
E. I. du Pont de Nemours and Co., Inc.

INTAKE system deposits prepared from a variety of commercial motor gasolines were compared by means of chromatography. These gasolines produced deposits of markedly varying weights, yet all deposits were chromatographically similar, suggesting that they were also chemically similar.

Intake deposit precursors in gasolines were studied with the aid of alumina packed adsorption columns with which

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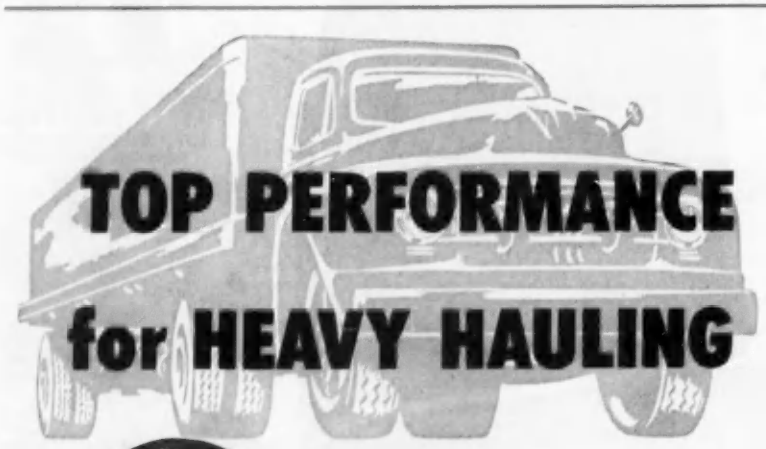
deposit precursors could be isolated and partially characterized.

From these studies it was observed that the deposit precursors from gasolines appear to be non-hydrocarbons which are very strongly adsorbed on alumina. They may be removed from the column to be analyzed and tested for their tendencies to turn a clean gasoline into one which gives intake deposits.

Deposit precursors on alumina are characterized by their tendency to appear in certain regions of a standardized column and by their resistance to displacement by benzene, the most strongly adsorbed hydrocarbon expected in gasoline. This behavior is quantitative enough to permit the use of an alumina column test for the depositing tendency. The test agrees rather well with laboratory engine test results.

Investigation has shown also that the alumina column concentrates compounds containing oxygen, sulfur, and nitrogen. Among these has been identified phenolic material. Phenols in the form of cresols do not contribute to deposit formation. Their sulfur analog thiophenol is markedly detrimental, while the aliphatic mercaptan, nio-butanethiol, appears to be less so. (Paper "Detection and Isolation of Induction System Deposit Precursors from Gasoline" was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 4, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)



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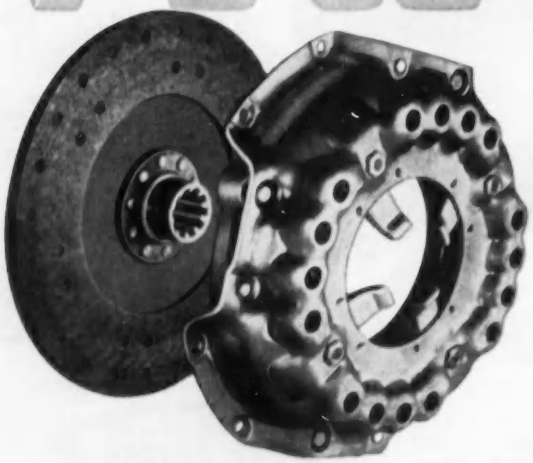

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Based on Discussion . . .

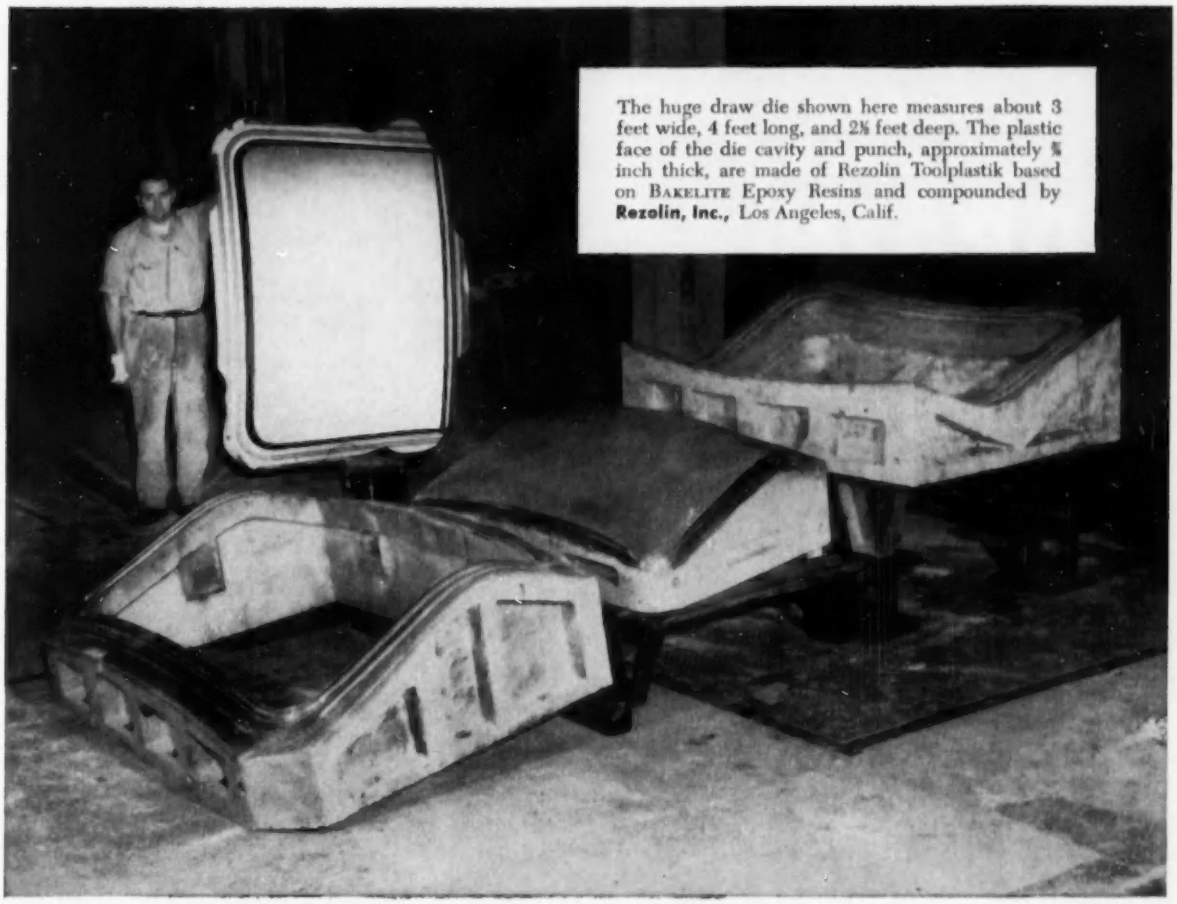
D. G. Roddick, Shell Development Co.

WE feel there is some danger in applying the results obtained since a single set of temperature conditions was used in the test manifold. This is particularly true since the temperatures (200 F ± 10) are higher than generally encountered in automotive equipment. It is, of course, desirable to use more stringent conditions to accelerate reactions, but we have found different gasolines reacting differently to varied temperatures. For example, we have noted that two gasolines may show similar depositing tendencies at say 50 C and 150 C, but be markedly different at an intermediate temperature of 100 C. In some cases the relative depositing tendencies of two fuels may even reverse their order as one changes temperature.

Commercial gasolines contain naphthalenes which, as pointed out by other researchers, are more strongly adsorbed than benzenes on silica gel. This is also true for alumina. Therefore, the possibility exists that this class of hydrocarbons may contribute to deposits.

Minor C. K. Jones, Esso Laboratory

IN catalytic cracking the aromatic mercaptans or thiophenols result primarily from the feed stock sulfur, so that high sulfur feeds produce the greatest amount of these mercaptans. Higher-boiling feed stocks also tend to produce more olefinic products. Thus the stability of catalytically cracked motor gasoline is very closely related to the concentrations of two of its minor components—aromatic mercaptans and reactive unsaturates. When present in combination in sufficient concentrations, these compounds result in extremely rapid peroxidation and gum formation upon contact with air. Removal of the aromatic mercaptans by prompt caustic washing before any possible contact with air corrects this initial extreme instability, and the concentration of reactive unsaturates in the caustic washed product then determines the stability level.



The huge draw die shown here measures about 3 feet wide, 4 feet long, and 2½ feet deep. The plastic face of the die cavity and punch, approximately ¾ inch thick, are made of Rezolin Toolplastik based on BAKELITE Epoxy Resins and compounded by **Rezolin, Inc.,** Los Angeles, Calif.

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When cured, the epoxy resin compound is hard and tough, with excellent impact, compression, and flexural strengths. The face of this die is only ¾ in. thick, yet it stamps sheet steel into auto trunk lids. If design changes are needed, the surface can be readily machined or patched to fit new contours.

Jigs, spotting racks, checking fixtures, and Keller models are examples of other metalworking tools made with these compounds—usually by laminating with glass cloth. This construction results in excellent dimensional stability and accuracy. Tools are lighter and easier to handle than when made of conventional materials. They are strong and durable because of the hardness of BAKELITE Epoxy Resins when cured.

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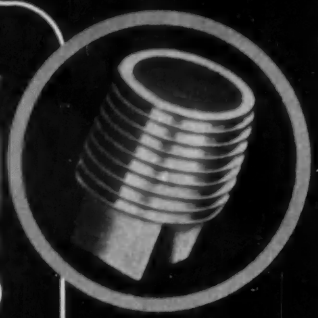

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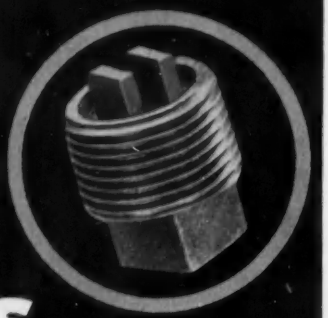

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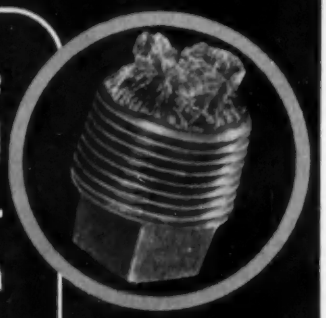

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High Additive Oils Can Add to Engine Life

Based on paper by

J. W. VOLLENTINE

Caterpillar Tractor Co.

THE most important factors affecting oil change periods for diesel field engines are the engine type and model, load, fuel composition and lubricating oil quality.

General observations and a study of used oil analysis indicate that if an engine with normal crankcase capacity, using a Series 2 oil, can be operated from 1000 to 1500 hr with a low deposit level, there will be no need to change oil to maintain adequate piston cleanliness. The analysis indicates that the oil activity level approaches a state of equilibrium after 1000 to 1500 hr and very slow if any additional deterioration occurs with further use.

The time required to reach equilibrium depends on the load placed on the oil, crankcase capacity and oil make-up rate. The activity level reached can be expected to depend upon the load placed on the oil and the oil make-up rate. If this level is high enough to satisfy engine needs, very light deposits will develop. If the level is insufficient, heavy deposits will form rather rapidly.

This is not said to recommend operating field engines without oil change. Many factors make oil changes desirable and even necessary. But such engines can be operated satisfactorily without oil change if precautions are taken.

Field tests with customer and proving-ground machines, powered with new or rebuilt engines and all run with Series 2 oils, lead us to the conclusion that engines not normally requiring high additive oils can use these oils with longer oil change periods to obtain increased engine life resulting from lower deposit levels and lower wear rates. The possibility of increasing oil drain periods depends primarily on engine model, load, and fuel characteristics, particularly the sulphur content. The increase in engine life can be two to three times that obtainable with lower additive level oils. (Paper, "Oil Change Periods in Diesel Engines with Series 2 Oils" was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 4, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on discussion . . .

B. E. Boswell Shell Oil Co.

From the viewpoint of controlling wear, the base concentration of the crankcase oil can have an important bearing on the criterion for oil change.

To determine the base concentration

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When Bell Aircraft's X-1A dropped from the mother B-29 and raced to 1650 mph and, in another flight, rocketed to an altitude of 90,000 feet, it flashed past a whole line of aviation milestones. The X-1A met the challenge . . . and so did the Elastic Stop nuts applied to critical airframe and engine fastenings. ESNA fasteners, with their familar red locking collars, have participated in every important airframe and engine development for more than twenty years. No test has ever been too severe, even when service conditions have been as unpredictable as they were during the epoch-making flights of the X-1A.

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Nylon INSERTS are standard on all ESNA fixed fasteners guaranteeing:

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For complete information, just contact your Garlock office or write for new O-Ring folder AD-148.

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK

at any operating interval in a field engine it is necessary to know the neutralization rate of the alkalinity in the oil for the operating conditions involved. It has been possible to measure accurately neutralization rate constants in laboratory engines operating under one set of conditions and to predict corresponding rates for field engines using oils of equivalent alkalinity regardless of the type of operation.

We agree that with Series 2 oils engine life can be much greater than that available with lower additive oils even at extended drain intervals.

W. L. Kent
Union Oil Co. of California

It is enlightening to study what happens in long oil change periods when fresh oil is added at regular intervals. Suppose we have an engine with 10 qt crankcase, using 1 qt every 10 hr. Assume a run of 50 hr at which time the oil level is down to 5 qt. Obviously the 5 qt have been subject to deterioration for 50 hr, but after adding 5 qt fresh oil the average time the oil has been in the crankcase is only 25 hr. If we repeat this sort of calculation for several more steps it is found that the maximum average time that the oil is subjected to service in this engine is 100 hr, no matter how long the engine runs without oil change.

Treated mathematically, the maximum "age" of the crankcase oil will be the time required to make up the original contents of the crankcase.

J. K. Appeldoorn, Esso Laboratories

In considering oil change intervals, it is important to find out what factor is governing engine life. If ring sticking is the cause of engine overhaul there is no point in extolling the virtues of using better oils or shorter oil drain periods in reducing crankcase sludge. Or if valve burning is the problem, there is little to be gained by showing the effects on piston skirt varnish.

Occasionally, a type of service is found where more frequent oil drains seem to be beneficial in every respect. Such was the case in a fleet test that we ran in gasoline trucks operating in inter-city over-the-road hauling. It was found that shorter oil drain periods reduced deposits, reduced wear, improved oil consumption, and greatly increased engine life.

In the case of this fleet, with oil drains every 2000 miles, the cost of the lubricant (DG quality) was less than 5% of the total of fuel/lube cost. If other operating costs were added—maintenance, tires, insurance, depreciation—the cost of the oil, percentagewise, would be reduced to less than half that figure. Doubling the oil drain period would therefore result in only a very small dollar saving—about 2% of the total fuel/lube cost—and this saving is not great enough to justify itself. The cost of more frequent drain periods almost certainly will be paid

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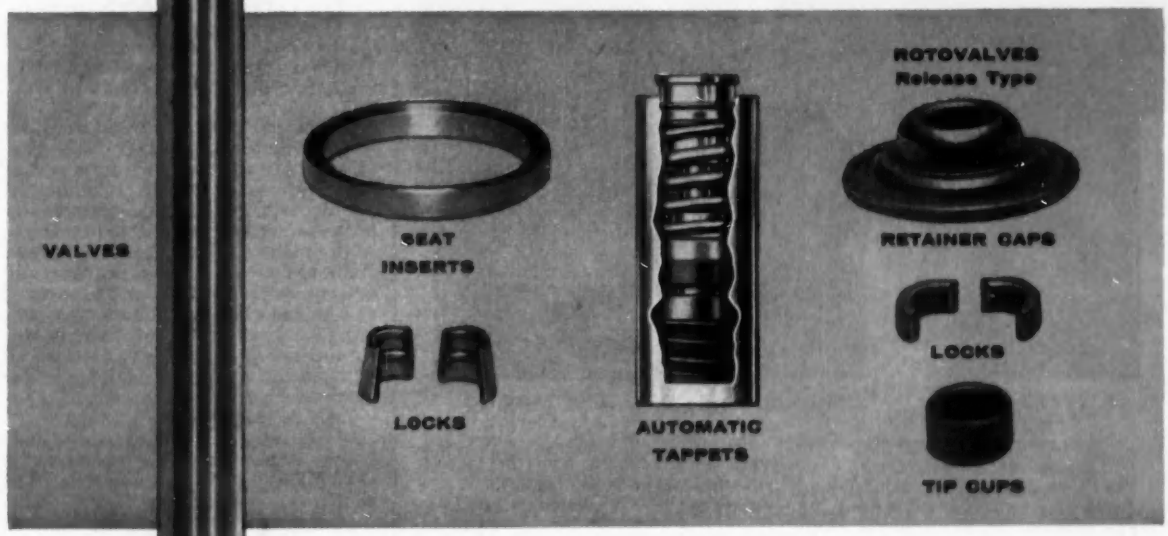

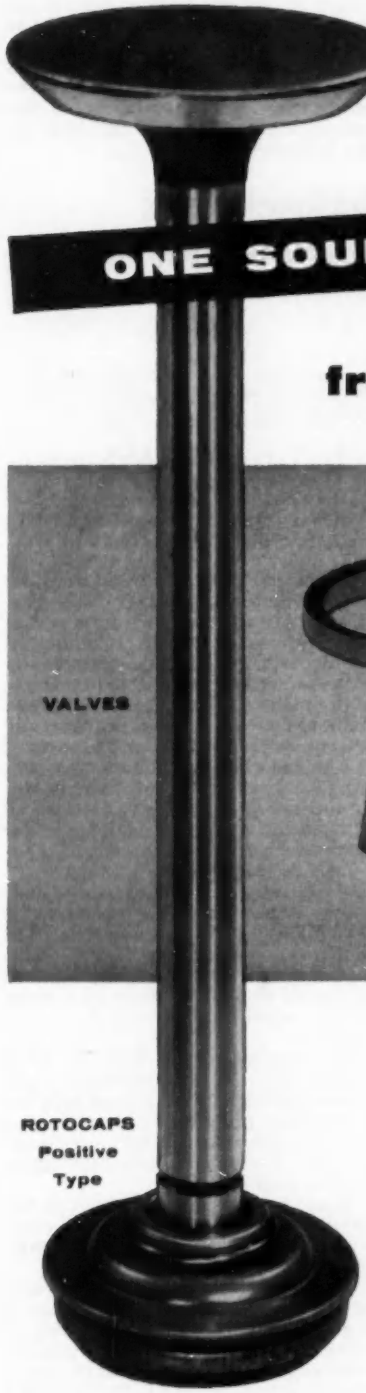

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CLEVELAND 17, OHIO

Applications of cathode-ray oscillography

VIBRATION STUDIES

TYPE 304A ORIGINAL BEARING NEW BEARING

The Physical Setup: A dental handpiece driven by a variable speed motor.

The Problem: To determine the effectiveness of a new bearing design in eliminating vibration from dental handpieces at high speeds.

The Solution: A piezoelectric-type vibration pickup is placed in contact with the side of a smooth shank similar to the shank of a dental burr which is locked in the handpiece under test. The handpiece itself is rigidly fixed in a vertical holder and is driven by a motor, the speed of which can be varied from zero to 10,000 rpm. The motor is mounted on sponge rubber to prevent transfer of vibrations through the table to the vibration pickup, giving a spurious reading. Thus, only vibrations from the handpiece bearings excite the vibration pickup.

The pickup rests on a sensitive lever balance so that various loads can be applied to the shank to simulate actual conditions of service. The output of the vibration pickup is applied to the vertical amplifier of a cathode-ray oscillograph* and the waveform, whose amplitude is proportional to amplitude of vibration, is recorded by an oscillograph-record camera**. The left-hand waveform shows a typical recording of vibration taken from a handpiece with the old style of bearing. The right-hand waveform shows the vibration in the redesigned bearing, taken at the same load and at the same speed of 4000 rpm. With the aid of the cathode-ray oscillograph, bearing design was greatly improved, helping to eliminate pain and tooth damage in patients and increasing the life of dental burrs.

An important application of Du Mont cathode-ray oscillography by the Kerr Manufacturing Company, Detroit, Michigan.

*Du Mont Type 304A
**Du Mont Type 296

A complete compilation of transducers is available from Du Mont for $3.00.

For further information concerning the Du Mont instruments used in this application, contact:

Technical Sales Department
ALLEN B. DU MONT LABORATORIES, INC.
760 Bloomfield Avenue, Clifton, New Jersey

DU MONT *for Oscillography*

back in longer engine life and lower engine maintenance cost.

Even if the relatively expensive DS quality oils were used, the cost of the oil would still be only a small fraction of the total cost, so that any savings from longer oil drain periods, or reduced maintenance costs, or in increased engine life would probably repay this cost.

Antiknock Needs Rose With 1953 Models

Based on paper by

H. W. BEST
Yale University

H. A. BIGLEY
Gulf Research and Development Co.

R. K. WILLIAMS
Research Laboratory Division, GMC

Complete paper will appear in 1955 SAE Transactions

DURING the 1953 CRC Octane Number Requirement Survey, 24 laboratories obtained data on a total of 235 cars, representing nine 1953 models having new design engines or transmissions. Octane number requirements were obtained in the cars as received from the owners, using primary and severity reference fuels and a series of full-boiling-range gasolines. The sensitivity (Research method versus Motor method rating) of these fuels varied with octane level in a manner similar to commercial gasolines.

Here in brief are the findings:

The Research method ratings of full-boiling-range gasolines required to satisfy 50% of the cars varied from 86 to 94 octane numbers for the nine models tested, while the rating required to satisfy 90% of the cars of a given model ranged from 90 to 96 octane number.

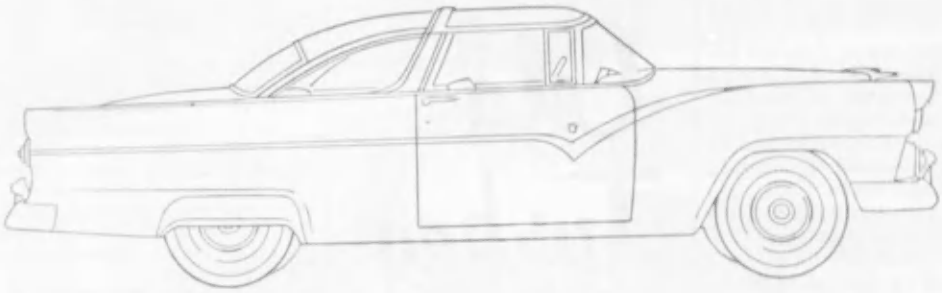
Requirements of the nine individual models with full-boiling-range gasolines were from 0 to 3 octane numbers higher than the primary reference fuel requirements at 10 and 50% cars satisfied, and 1 to 4 octane numbers higher at 90% cars satisfied.

In general, the severity reference fuel requirements were within the range covered by the primary and full-boiling-range fuels.

Six of the 1953 models tested were of the same make as those tested in previous surveys. One model, with no significant design changes between 1952 and 1953, showed substantially no change in requirement in the 50 to 90% satisfied range. The other five models which did have significant design changes showed increases from 2 to 6 octane numbers over previous models.

The 95% confidence limits of the distribution curves for the nine models ranged from ± 1.3 to ± 2.4 octane numbers at the midpoint of the curve (50% satisfied). Only two of the nine models had confidence limits greater than ± 1.5 octane numbers.

Maximum requirement occurred at



Under the hood of the smart new Ford . . .

Neoprene protects ignition wire and spark plugs against moisture . . . resists ozone, heat and oil

Designers made sure the smart-looking 1955 Ford would be off to a fast start in any weather. On both the "Six" and the "Eight" they chose spark-plug covers and ignition-wire jackets made with neoprene for positive protection against moisture and deterioration.

Neoprene covers prevent seepage of moisture to the spark plugs . . . provide instant, all-weather action. And the sturdy neoprene jacket on the ignition wire protects the insulation against heat and oil.

Moreover, neoprene stays on the job . . . has what it takes to give long, dependable service. It resists ozone and other effects of corona discharge . . . remains firm and strong despite heat, oil and grease . . . won't chip, crack or soften.

Each year finds more automotive parts and accessories made with neoprene, Du Pont's chemical rubber. Because it stands up where ordinary resilient materials fail, neoprene is first choice among designers for key parts that improve performance . . . rarely need replacement.

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Empty promises are strictly for the birds. Here's the true story of what an engineer's future can be. Fairchild Engine Division's new plant and Advanced Engine Test Laboratory at Deer Park, L. I. are the most modern, newest and best equipped facilities in America today for the development of propulsion systems for target drones, guided missiles and piloted aircraft utilizing new fuels and principles of propulsion. In other words, a good place for the right man to feather his nest, where he can be sure of stimulating work and the chance to see his own ideas realized and rewarded. Right now, Fairchild wants: Design engineers, Project engineers, Installation engineers, Aerodynamists, Thermodynamists, Stress analysts. Please write to me today: Felix Gardner, Fairchild Engine Division, Farmingdale, Long Island, New York. Empty promises are strictly for the birds. Here's the true story of what an engineer's future can be. Fairchild Engine Division's new plant and Advanced Engine Test Laboratory at Deer Park, L. I. are the most modern, newest and

Cold Turkey

...let's talk cold facts about your future

Empty promises are strictly for the birds. Here's the true story of what an engineer's future *can* be.

Fairchild Engine Division's new plant and Advanced Engine Test Laboratory at Deer Park, L. I., are the most modern, newest and best equipped facilities in America today for the development of propulsion systems for target drones, guided missiles and piloted aircraft utilizing new fuels and principles of propulsion.

In other words Fairchild is a good place for the right man to feather his nest—where he can be sure of stimulating work and the chance to see his own ideas realized and rewarded. Right now, Fairchild wants:

Design engineers
Project engineers
Installation engineers
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Stress analysts

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ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Engine Division
FARMINGDALE, LONG ISLAND, NEW YORK

"where the future is measured in light-years"

part throttle in 95% of cars of one model, the other models ranging from 0 to 64%. For cars having maximum requirements at part throttle, the average difference between part- and full-throttle requirement varied from 0.5 to 5 octane numbers for the different models. The maximum increase observed in any one car was 10 octane numbers.

The speed at which the majority of cars of an individual make showed maximum requirement varied from 750 to 2000 rpm.

Observers reported 46% of cars to be knock-free on the tank fuel while owners reported 60%.

The average requirements of 32 of the cars tested under hill-climbing conditions was 2.4 octane numbers higher than the level-road requirement.

Surface ignition was observed in 9% of cars when operating on reference fuels at or above the maximum requirement level, and in 7% of cars operating on the tank fuel. (Paper "Antiknock Requirements of Passenger Cars—1953 CRC Survey" was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 5, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Diesels Underneath In New Budd Rail Car

Based on paper by

N. W. FESMIRE

The Budd Co.

TWO diesel engines of 275 hp each and torque converters power the Budd diesel rail car. Since each engine could be laid on its side at an angle of 20 deg above horizontal because the final drive from the transmission was offset with the engine crankshaft, it was possible to mount the power units under the car. This eliminates encroachment on the passenger section and allows continuity of primary structure such as center and side sills.

The power unit selected has several advantages:

1. It gives greater operating reliability. If one power unit fails the car can be operated at reduced speed to complete the run on one engine.

2. It simplifies final drive from power unit to truck.

3. It provides two driving axles per car which gives required rail adhesion for weight.

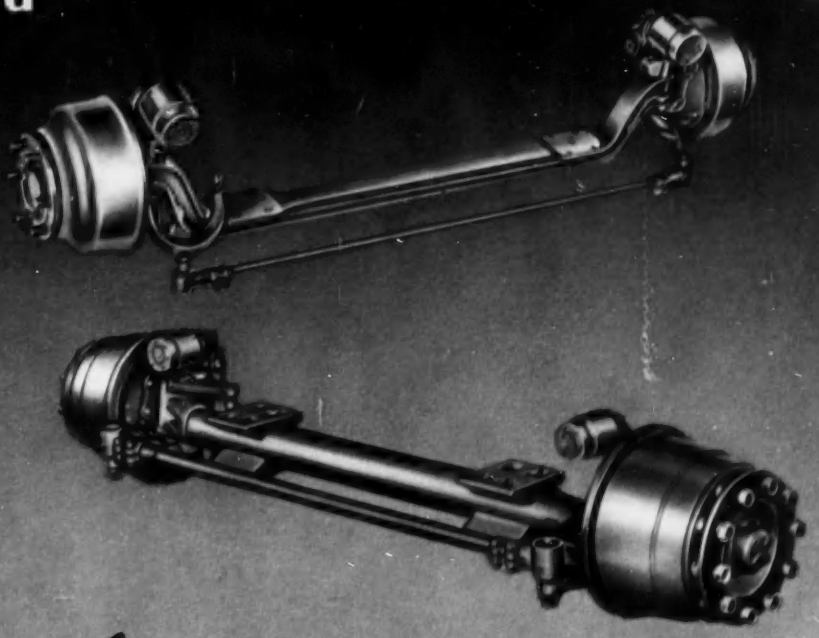
4. Each unit is light enough for easy handling. Engine changeout can be effected in 4 hr without tying up the entire car.

continued on page 131

Known and Respected

A whole automotive generation—especially men who operate vehicles for revenue—knows and respects Clark Front Steering Axles. Veteran "shock troops"—out in front, absorbing the punishment of modern heavy-duty transport at high speeds.

It is Clark policy that these axles shall continue to command respect by generations to come—and that it shall be, as in the past, good business to do business with Clark



CLARK EQUIPMENT COMPANY • BUCHANAN • Battle Creek, Benton Harbor and Jackson, Michigan

Announcing the Clark-Ross Y-200-

DESIGNED SPECIFICALLY For 20,000 lb. Jobs!

CHECK THESE FEATURES:

Heaviest uprights in the industry: Hi-tensile steel channel specially rolled for this truck.

Shortest turning radius: 15 feet; shorter than any other comparable truck.

3 in. thick steel steer axle.

10 in. underclearance at uprights, plus excellent weight distribution, permit operations under most severe yard conditions.

Safety check-valve built-in: a Clark-Ross exclusive; impossible to drop the load because of line failure.

Planetary gear drive: takes the strain off the axle; all drive components protected.

Extremely easy to service: hydraulic cylinder serviced from bottom, no need to remove uprights; engine and hydraulic system easily accessible.

From the ground up, the Y-200 is a genuine 20,000 lb. truck—not merely a beefed-up truck of less capacity. Pre-production models have been job-tested for nearly a year at steel mills, sawmills and wood treating yard.* These trucks have proved their ability to cut handling costs under the toughest conditions. We are frank to say that we believe the Y-200 will give you better performance, at less cost, than any comparable machine. We invite your comparison: Simply call your local Clark dealer, listed under "Trucks Industrial." Or write us direct. There's no obligation.

*Names supplied on request.

CLARK EQUIPMENT

ROSS CARRIER DIVISION
Industrial Truck Division
CLARK EQUIPMENT COMPANY
Battle Creek, Michigan

5. Great industrial demand for 275 hp engines gives the manufacturer volume production, reducing initial cost as well as parts cost. (Paper "The Budd Rail Diesel Car" was presented at SAE Metropolitan Section, New York, Jan. 6, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

New Diluent Test Set For Railway Diesel Oil

Based on paper by

L. L. DAVIS

and

H. E. LUNTZ

Continental Oil Co.

DECREASE in viscosity and flash point of diesel lubricating oil due to dilution may affect the safe operation of railway locomotives. Hence there is real need for a simple and quick test to determine the quality of used oil in actual service.

To devise a test which would overcome the drawbacks of existing methods, a graphic correlation has been developed between the amount of diluent and the resultant decrease in flash and viscosity. With its use, reasonably accurate estimates can be made of the amount and character of the diluent from the flash and viscosity of the used oil.

An example of graphic correlation is shown in Fig. 1. It was prepared from blends of railway diesel engine oil with three diluents. The scales represent the decrease in flash and viscosity caused by diluent. The nearly flat curves are lines of constant per cent diluent, and the three curves indicate the character of the diluent.

To estimate the amount and kind of diluent in a sample of used oil, the flash (Pensky-Martens—F) and the viscosity (centistokes at 100 F) are determined on the used oil and the decrease in flash and viscosity calculated by subtracting the measured values from the values for the unused oil. The point on the chart represented by the decrease in flash and viscosity indicates the per cent of diluent, and the position along the viscosity line in relation to the diluent lines indicates its general character.

Correlation charts may be prepared from either experimental blend data or from calculations based on viscosity and flash correlations. If it is impractical to use actual experimental data, the decrease in flash and viscosity may be estimated with a fair degree of accuracy.

(Paper "Determination of Diluent in Used Railway Diesel Lubricating Oils" was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 4, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

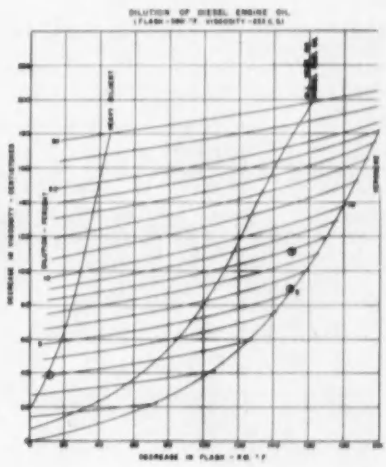


Fig. 1—A graphic correlation between the amount of diluent and resultant decrease in flash and viscosity, prepared from blends of railway diesel engine oil with three diluents. Scales represent decreases in flash and viscosity. Nearly parallel flat curves are lines of constant per cent diluent. The three curves indicate character of diluent

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WEIGHING UP TO 4000 LBS.

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CLEVELAND 3, OHIO

New Method Aids Thin Wing Designing

Based on paper by

WILLIAM J. CONWAY
Lockheed Aircraft Corp.

A SIMPLE method has been developed for determining the optimum proportions for minimum weight multi-spar box beams in pure bending. It is assumed, in this development, that simultaneous failure of the skin in compression and the web in crushing of a concentric pin-connected multi-spar constitutes the basis for optimum structure in pure bending.

Test results, using formed channels with small bend radii, indicate that these assumptions closely approximate the behavior and proportions of the optimum structure for straight thin wings.

The method enables design charts to be constructed for specific materials. (Paper "Factors Affecting the Design of Thin Wings" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 7, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

New TUNG-SOL All-Glass Sealed Beam
VISION-AID HEADLAMP
IMPROVED BEAM PROVIDES BETTER VISIBILITY

Conventional sealed beam headlamp radiates as per of stray light. This uncontrolled light causes
Vision-Aid Headlamp emits little stray light—almost none above the usual beam level. Drivers
ensuring to approaching drivers.

VISION-AID HEADLAMP is the most powerful and the safest headlamp ever developed. Light output has been increased by raising the lower beam wattage from 35 to 40 and the upper beam from 45 to 50 watts.

VISION-AID HEADLAMP provides 23 per cent more light on the low beam and 26 per cent more light on the high beam.

VISION-AID HEADLAMP projects the passing beam up to 80 feet farther ahead, but more to the right, at the same time reducing the amount of light directed toward an approaching vehicle.

VISION-AID HEADLAMP produces less uncontrolled light, thereby reducing the light reflected back at the driver from fog, rain, dust or snow encountered in bad weather.

TWO TYPES
5040 for 6 volts
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Nitromethane Additive Boosts Engine Power

Based on paper by

E. S. STARKMAN
University of California

USE of nitromethane as an additive in either alcohol or hydrocarbons will increase the power output of a piston engine. Added to methyl alcohol this increase can run as high as 13% on an indicated or gross basis; with a benzine-isooctane mixture the rise is 7%. This power increase can be traced directly to the additional energy made available to the fuel-air mixture by the additive.

The amount of nitromethane which can be added to a given fuel is limited by the tendency for the additive to bring about preignition. In methanol this concentration at 6 to 1 compression ratio, 125 F inlet temperature, and CFR supercharge conditions, amounts to 20% by volume. This concentration also is the limiting one when blended in an equal volume benzine-isooctane mixture.

Increased fuel consumption in terms of pounds of fuel per indicated horsepower always results when nitromethane is used as an additive to a normal fuel. However, there is also an increase in thermal efficiency. This apparent divergence is due to the relatively low heating value of nitromethane.

Considerable mixture enrichment is needed in order to utilize the properties of nitromethane at the optimum power output level because of the shift in the resulting optimum mixture ratio. (Paper, "Nitromethane as a Piston Engine Fuel" was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 5, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

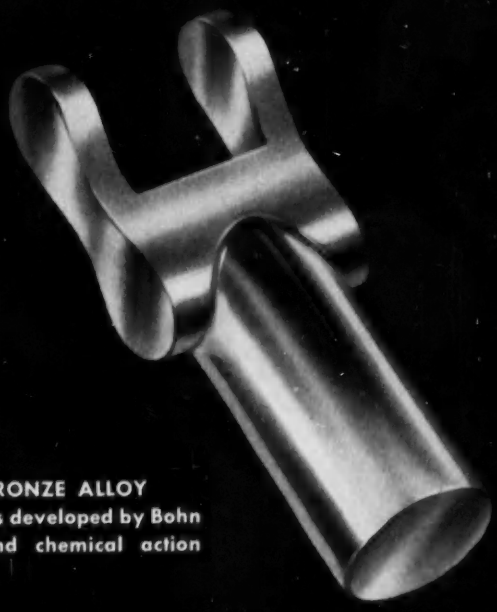
Based on discussion . . .

J. B. Platner Chrysler Corp.

When experimenting with nitromethane fuels in a single cylinder engine at 7 to 1 compression ratio, indicated gains were found to be slightly less than those reported by Prof. Starkman. Preignition was encountered at approximately the same concentration (20%). However, it was found possible to raise the limit considerably

The Case of the Forgings that Failed

COMMERCIAL BRASS ALLOY
forgings corroded rapidly in use due to chemical condition



SPECIAL BRONZE ALLOY
forging was developed by Bohn to withstand chemical action

PROBLEM:

A manufacturer of plumbing fixtures found replacement costs mounting on a metal component. Customer complaints began to affect sales. The part was a commercial brass alloy forging. Investigation showed that chemicals present in the water in certain parts of the country were causing the parts to corrode rapidly in use.

SOLUTION:

Bohn engineers were consulted and Bohn's research laboratories went to work. After isolating the chemicals, they conducted a series of corrosion tests. From the results, they developed a special bronze forging alloy which would withstand the action of these chemicals.

RESULT:

Replacement of the component because of corrosion was *completely eliminated*. Product confidence was restored.

BOHN

ALUMINUM & BRASS CORPORATION

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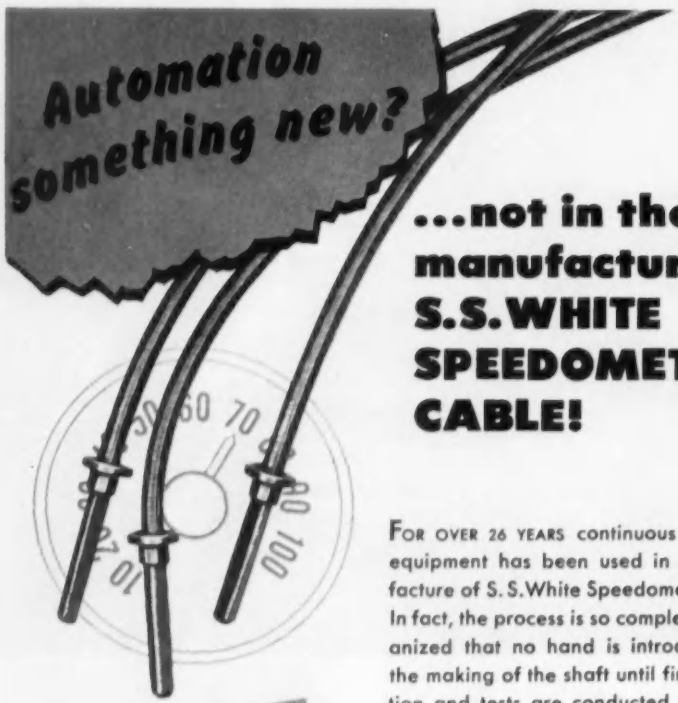
beyond that required for test purposes by removing a protruding gasket and smoothing all sharp edges in the combustion chamber. Examination at the end of a series of runs disclosed a cylinder bore and ring wear many times greater than anything we have ever observed regardless of the period or condition of operation.

In power runs with a multicylinder racing engine of 13 to 1 compression ratio, no particular difficulty from preignition or detonation was experienced at any time when using a 10% nitromethane blend.

Discussion from floor

M. E. Russell, Ethyl Corp., reported California hotrodders using up to 80 or 90% nitromethane in their fuels and regarding 20% as child's play. He wanted to know why higher concentrations could be used in drag races but not in the University experiments. In reply, Prof. Starkman explained that engines were started cold in drag races and operated for only a quarter of a mile or so. Under these conditions fuels could be used which would not permit steady operation.

Mr. Russell then indicated that in hotrod racing nitromethane gave little increase in performance as the concentration was increased between 20 and 60%, but that over 60% brought large increases.



...not in the manufacture of S.S.WHITE SPEEDOMETER CABLE!

FOR OVER 26 YEARS continuous automatic equipment has been used in the manufacture of S.S.White Speedometer Cable. In fact, the process is so completely mechanized that no hand is introduced into the making of the shaft until final inspection and tests are conducted under formal quality control procedures.

Automation is thus responsible for cable in which tension is controlled and held to close limits and is one of the factors that contribute to the outstanding performance characteristics and quality of S.S.White Speedometer Cable. It's just one more reason why you, as an automotive manufacturer can specify S.S.White Cable with confidence from your speedometer supplier.

S. S. WHITE "FIRSTS" have meant better, more economical speedometer cable

FIRST to pioneer the use of flexible wire wound cable.

FIRST to introduce automation in speedometer cable manufacturing.

FIRST to develop machines for precutting speedometer cable.

FIRST to introduce integral drive squares.

FIRST to develop satisfactory swaging equipment for speedometer cable.

FIRST to develop small diameter, thin wall speedometer casing.

FIRST to introduce galvanized casings for speedometer service.

THE S.S.WHITE INDUSTRIAL DIVISION,
10 East 40th Street, New York 16, N. Y.

B-3

FIRST NAME
S.S.White
in flexible shafts for speedometer drives, industrial power drives and remote control.

Turboprop Scores In Large Seaplane

Based on paper by

W. W. WITHEE
Consolidated Vultee Aircraft Corp.

CONVAIR has designed two nacelle configurations around the Allison T-40 turboprop engine for large seaplanes. The nacelle for the XP5Y-1 seaplane was a "buried" version made possible by a long shaft between the engine and the gearbox. The R3Y-1, on the other hand, has an "over the wing" nacelle located forward on the wing with a short shaft between engine and gear box.

There were five basic reasons for selecting the nacelle configuration for the R3Y-1 seaplane, as follows:

1. The short coupled engine is considered to provide the most readily handled and reliable T-40 engine arrangement.
2. Engine installation above the wing provides the required propeller clearance with the water and maximum use of the wing for fuel storage.
3. Installing the engine well forward provides an air inlet which is as high and as far forward as possible in order to reduce water ingestion to a minimum during landing and take-off. It also positions the engine lateral fire wall ahead of the wing front spar.
4. The nacelle structure provides an installation permitting complete access from above to all engine components while the seaplane is on the water.
5. The nacelle access doors, which form the top of the plenum chamber and engine accessory compartment, open out to create work platforms for the area.

Convair believes that the turboprop engine has proved that it has a place of its own in the aircraft industry and is not a stepping stone to the turbojet. (Paper "Turboprop Installation in Large Water Based Aircraft" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 8, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Martin "404"—Courtesy of The Glenn L. Martin Company

Ever try flying without vibration control?

It just can't be done! At least not with the comfort and safety that are taken for granted in modern aviation. Lord Vibration Control systems play an important part in every type of aircraft—isolating the vibration of powerful engines, protecting the accuracy of vital and delicate instruments, and insuring the comfort of operators and passengers.

With the same effectiveness, Lord Vibration Control enhances the performance of all types of mechanical equipment—providing quieter, more efficient operation.

The distinct advantages of Lord Vibration Control systems are the result of three important factors. First is Lord's extensive knowledge of vibration causes, effects and control gained through 30-plus years of experience devoted exclusively to this field.

Second is the completeness of Lord facilities for every phase of vibration research, control engineering, and precision volume production of uniform, high quality products.

Third is the use of quality materials in all Lord products — each selected and proved for maximum performance.

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Automobile and Truck Frames • Air and Vacuum Power Brakes
Air and Electro-Pneumatic Door Controls

New Members Qualified

These applicants qualified for admission to the Society between March 10, 1955 and April 10, 1955. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Atlanta Section

Carl Frederick Friend (M).

Buffalo Section

Jack A. Eckardt (A), Paul F. Furgerson (M), Elbert R. Hubbard (M), John F. Nagowski (A).

Canadian Section

Warren Taylor Bryan (A), James G. Garbutt (J), John George Pearson (A), John Phillips Perry (M), William Wesley Stewart (M), Bertram Tilley (M).

Central Illinois Section

Raymond E. Andrews (J), Francis Edward Cambron (J), John Cenko (J), Louis F. Crystal (M), Jack A. Drais (M), Irwin L. Joslin (M), Walter E. Lott (M), John H. Pritt (M).

Chicago Section

Joseph S. Berg (A), Jose G. Caero (J), Donald F. Domnick (M), Edgar B. Fields (M), Carl R. Freberg (M), R. L. Gilmore (M), Stephen Edward Grenleski, Jr. (J), John Gowan Haig (A), L. W. Kinney (M), Frank A. Kocian (M), Alan Carl Skinrood (J), J. W. Van Cleave (M).

Cincinnati Section

D. Q. Marshall (M), Hilliard W. Paige (M), Forrest Webster (A).

Cleveland Section

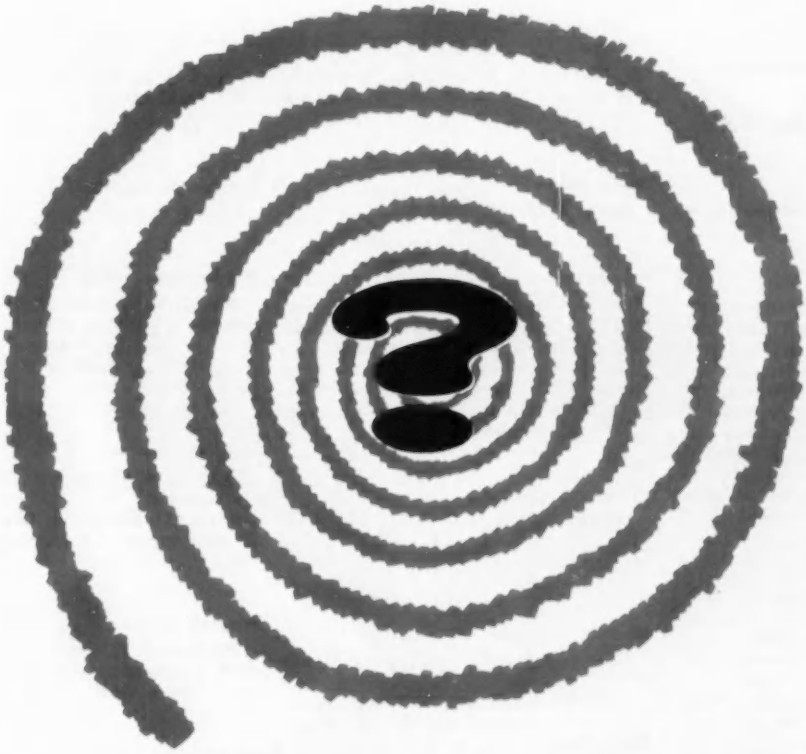
Eugene Bahniuk (J), Robert E. Davies (M), Andrew James Grega (J), Anthony B. Kubala (M), Everett Marra (M), H. E. van Driest (A).

Dayton Section

Glenn W. Periman (M).

Detroit Section

Bruce A. Allen (A), Clarence C. Bartell (A), Herbert Vall Beck (M), Marvin A. Bennett (M), Andrew Beresik (A), Robert A. Brunner (J), Wendell P. Campbell (J), Thomas R. Cassel (J), J. S. Collman (M), William Duncan (A), Joseph E. Faggan (M), Charles A. Gibson (J), George E.



WHICH CAUSES MOST AUTO ACCIDENTS?

- ◯ PUNCTURE OR BLOWOUT
- ◯ DEFECTIVE STEERING
- ◯ DEFECTIVE BRAKES
- ◯ DEFECTIVE TAIL LIGHT
- ◯ DEFECTIVE HEADLIGHTS

(Check one of these before reading further.)

If you checked brakes, you're right. Insurance statistics show that defective brakes are responsible for more than twice as many auto accidents as any of the other causes.

Better brakes can prevent many of these accidents. Better brakes can save lives. Auto Specialties Double-Disc Brakes are better brakes. They're ready for passenger cars now.

They can stop cars quicker, safer, smoother . . . and in shorter distances. They give the same amount of braking every time the same pressure is applied to the pedal. They are predictable and uniform in their performance. You always know what they are going to do. They have "built-in", self-energized power that is not dependent on the efficiency of boosters, tanks, tubing, diaphragms, etc. They don't lose effectiveness because of roadspray, water, freezing or dust.

And this life-saving accident prevention . . . this safe-and-sure stopping . . . continues as long as you drive a car equipped with Auto Specialties Double-Disc Brakes. Because these better brakes have an *automatic* adjuster that keeps them in perfect condition always. And they rarely need relining.

But Auto Specialties Double-Disc Brakes do more than prevent accidents. They can create a new kind of motoring. Worry-free, relaxed, restful, enjoyable driving and riding . . . that results from knowing that they are the smoothest, surest, straightest stopping brakes engineers have yet devised.

Auto Specialties Self-Energized Double-Disc Brakes have passed the severe testing of major car factories. Their cost is comparable to that of present automotive brakes. Their adoption will be in keeping with increased horsepower and speed and with the industry's continuing desire to give the American motorist better, safer and more pleasant means of transportation.

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Plants also at Benton Harbor and Hartford, Mich., and Windsor, Ont., Canada
Manufacturing for the automotive and farm machinery industry since 1908

New Members Qualified

continued

Gormly, Jr. (J), Carl E. Granfors (M), Roy Haeusler (M), Robert T. Hall (M), Arthur C. Hays (M), Robert E. Heintz (J), Edward T. Hendzel (J), Alec Eric Hewlett (A), James J. Hovorka (J), Maynard J. Isley (M), Norman E. Janke (M), Charles M. Jordan (J), Clyde E. Juntunen (M), Richard L. Kellogg (J), Axel W. Kogstrom, Jr. (J), Walter H. Kremkow (M), Herbert F. Krug, Jr. (A), Fred Norman Krull (J), Richard P. Krygowski (J), Charles M. Levy (J), George William Michel (J), Dale O. Miller (M), Frank L. Moncher (M), C. J. Moody (M), Robert S. Nelson (M), Robert W. Overman (A), Burnet J. Powell (M), Joseph Roth (J), George A. Stonex (M), Jordan H. Stover, III (M), Le Grand E. Terry (M), Kenneth Edward Thorp (J), R. F. Tomkinson (A), Alphonse C. Van Ermen (M), Byron D. Waters (J), William L. Weeks (M), Willem L. Weertman (J), John B. Whitehouse (A).

Hawaii Section

David A. Gowans (M).

Indiana Section

Charles Raymond Boll, Jr. (M), Alfred Noah Cave (J), Raymond George Fischer (J), Theodore G. George (J), Karl L. Kleimenhagen (J), Rine Kruger (M), Russell J. Limer (M), Herman G. Riggs (M), Marvin Stohler (J), Paul Webster Vinson (J).

Kansas City Section

Robert O. Ballou (A), John W. Burke (M), Frank D. Froh (A), Henry W. Wilson (M).

Metropolitan Section

Jack Azoff (J), Tallmadge Leslie Boyd (A), Stanley W. Burgess (M), Angelo T. Deieso (A), Snowman Whittier Doe (A), Harry Epstein (M), David Paul Fischer (J), O. S. Grunden (M), Charles H. Lance (A), Francis Mangin (M), Paul A. Steidel (J), Donald B. Weir (A).

Mid-Continent Section

Don E. Welch (A).

Mid-Michigan Section

Joseph W. Arnett, Jr. (J), Frederick Eugene Cole (J), Robert N. Khouri (M), L. Harvey Petree (A), Dimitar Toschkoff (M), James W. Tweedy (A), Ray J. Wilcox (M).

Milwaukee Section

William J. Feiereisen (M), Glen W. Hufschmidt (M), Charles Edward Jordan (J), Robert W. Lange (J), Carl H. Rasmussen (A), John Schmutzer (A).

Montreal Section

Richard E. H. Berryman (M), Frederick Carrington Purvis (M), Percival John Waite (M).

New England Section

George A. Amet (M), Hugh D. Hardinger (M), David W. Weiss (J).

Northwest Section

Roy F. Christensen (M), Robert B. Waggoner (A).

Oregon Section

Fred D. Fulton (M).

Philadelphia Section

Robert H. Blaker (M), Edward Norton Cantwell, Jr. (J), M. W. Corzilius (J), Alexander Duncan Kidd (J), Anton O. Melby (M), William E. Schluter (A), Isadore M. Scott (A).

Pittsburgh Section

Chalsmer K. Brown (M), Harry J. Conlan (M).

St. Louis Section

Ralph B. Cornell (M), Harvey S. Gershenson (J).

San Diego Section

Donald A. Brownell (M), Allen L. Smith (M).

Southern California Section

John R. Bogue (M), Read B. Chilcoat (A), Gordon L. Churchill (A), Charles J. Cramer (A), Thomas E. Depkovich

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WISCONSIN Air-Cooled ENGINES
Fit the Job and the Machine
Because Wisconsin Air-Cooled Engines are supplied in a complete power range, from 3 to 36 H.P., in 4-cycle single cylinder, 2- and 4-cylinder types, there is an ideal size to fit all types of machines and power applications within this range, without wasted power and with maximum power service benefits. Heavy-duty construction, combined with extremely compact design and light weight are added advantages—and dependable AIR-COOLING permits trouble-free service under all climatic conditions.
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Single cyl. 3 to 9 H.P.
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The kids who roll down Oak Hill in a coaster wagon, and those of us who ride in the world's best automobiles, put a lot of faith in flat-rolled steel.

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FROM WAUSAU...
WF-3-0
SINTERED IRON PISTON RINGS

Wausau's new WF-3-0 sintered iron piston rings work better and cost less. Here are several of their outstanding advantages:

- Higher Tensile Strength
- Vastly Increased Modulus of Elasticity
- Lengthened Tension Life
- Greater Stability
- Lower-Cost
- Increased Lubrication Retention
- Improved Wear Resistance
- Expanded Design Flexibility

SMALL ENGINES

AUTOMATIC TRANSMISSIONS

HYDRAULIC EQUIPMENT

PIONEERS IN PISTON AND SEALING RING RESEARCH AND DEVELOPMENT

WAUSAU
MOTOR PARTS COMPANY
2200 Harrison Boulevard, Wausau, Wisconsin

For more details see next page

New Members Qualified

continued

(M), Leigh E. Dunn (M), Lon A. Fleener (A), George H. Fox, Jr. (M), John Collinson Grafton (J), Lisle D. Horton (A), R. W. Howell (M), William Julian King (M), Anthony M. Maggio (A), James F. McLaughlin (J), Donald J. Murphy (M), Herbert M. Palmtag (A), William Joseph Ryan (A), Alfred L. Seaberg (A), Leland Marlin Tate (J), Richard L. Tonks (M).

Southern New England Section

Charles William Darling (J), Robert H. Wilkie (A).

Texas Section

Charles T. Ashford, III (J), C. L. Robinson (M), William Gardner Stanfield (J), Alonzo D. Tuttle (M).

Texas Gulf Coast Section

Leon Blagg (M), Bobby Joe Warren (J).

Twin City Section

John C. Bandli (M), James F. West (A).

Washington Section

John D. E. Egerton-Smith (M).

Western Michigan Section

William I. Barnes (J), Owen D. Premo (M).

Wichita Section

Lyman H. Welliver (A).

Outside Section Territory

Howard Roger Bahls (J), Charles Russell Cheney (M), Theo E. Deal (M), John E. Helms (A), John G. Hoffman, Jr. (J), Sanford S. Maremont (M), D. Richard Olinger (M), Otha Howard Vaughan, Jr. (J), Jake Wellman (A).

Foreign

Oscar Bromberg (J), Germany; Alain de Boysson (M), France; Yusuf Fikret Gurturk (J), Turkey; Francis Stanley Tennyson Hallam (M), Australia; Philip L. Hepworth (M), New Zealand; Fernando J. Rodriguez S. (A), Mexico; Sunil Chandra Sen (M), India; Heijiro Shiguma (M), Japan; Penmetcha Somaraju (J), South India; F. F. Van Quaethoven (J), Belgium; Albert L. Weeks (M), England; Kamil Yigit (M), Turkey.

Applications Received

The applications for membership received between March 10, 1955 and April 10, 1955 are listed below.

Baltimore Section

Alfred L. Kerekes, Winfred L. Shirley.

British Columbia Section

Hugh J. Kippan.

Buffalo Section

John H. Townley.

Canadian Section

Victor F. Baumunk, Charles B. Benton, James D. Dixon, Theodore M. Green, A. C. Jamieson, John A. McGiffin, Thomas G. Neelands, Ralph K. Shantz, Samuel Sperling, Harris C. D. Veitch.

Central-Illinois Section

Charles Brown, William E. Budd, Harold C. Wiggers.

Chicago Section

Harold E. Greenlee, Richard H. Hinchcliff, James H. Kahlke, Warren G. Kingsley, J. Dean Meyer, Frank W. Rasmussen, J. William Tellson, H. T. Thompson.

Cincinnati Section

H. A. Fremont, Willard G. Snyder, John M. Wachsmuth, Richard E. Weymouth.

Cleveland Section

Earl G. Cummings, E. W. Husemann, Joseph F. Hutchinson, Whitmell T. Rison, Ernest N. Scarborough, Robert O. Webb, Donald R. Wilcox.

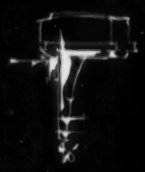
Dayton Section

Paul F. Joseph, Allan U. Macartney.

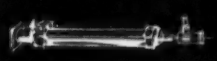
Detroit Section

Robert C. Andrews, C. Robert Bassett, Louis C. Bettega, V. E. Boehne, Gordon L. Buyck, Thayer M. Cowman, Andrew J. Crockett, Richard R. Golze, Daniel W. Hall, John E. Herrold, Eugene F. Hill, Donald A. Jones, Joseph Kwaselow, Robert R. Lange, Gerald R. McCloskey, James C. McInnis, Richard E. Merrill, Walter J. Miller, Richard T. Noe, Richard J. Piersol, George J.

NOW!
FROM WAUSAU...
WF-3-0
SINTERED IRON PISTON RINGS



OUTBOARD ENGINES



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AIR COMPRESSORS

Wausau's new WF-3-0 sintered iron piston rings work better and cost less! Simplified high production techniques have resulted in significant cost reductions which can be translated into important yearly savings for volume users of piston and sealing rings.

The high tensile strength of Wausau WF-3-0 together with its sharply increased modulus of elasticity assures excellent ring stability and reduces tension loss in service well below previously accepted iron ring standards. Reduced and very uniform density permits increased lubrication which, together with the inherent characteristics of the metal results in a high degree of wear resistance and a strong resistance to scuffing and scoring.

Wausau WF-3-0 sintered rings introduce a completely new concept of design flexibility. They provide new performance standards as well as lower cost levels.

Full and complete information may be had by communicating with Wausau Motor Parts Company. We will welcome the opportunity to discuss WF-3-0 in connection with your piston or sealing ring problems.

PIONEERS IN PISTON AND SEALING RING RESEARCH AND DEVELOPMENT

WAUSAU
MOTOR PARTS COMPANY
2200 Harrison Boulevard, Wausau, Wisconsin

Applications Received

continued

Porth, Henry T. Schlachter, Lyle D. Sheckler, Richard J. Stark, James C. Streicher, Henry Whiting, Jr.

Hawaii Section

James L. Shetterly.

Indiana Section

John D. Baker, Richard J. Brehm, Philip L. Fosburg, Joe White.

Kansas City Section

John B. Graef, Peter M. Sarles.

Metropolitan Section

Stanley Braun, J. Clifford Crawford, Michael F. DeMarco, Jerome O. Feldman, Cranston W. Folley, Lawson H. Frew, Rudolph L. Graupe, George F. Lohr, Robert E. Loren, Milo F. McCammon, Walter D. McKinley, Harry R. McNeal, James J. Wagner.

Mid-Continent Section

Bert S. Davenport, Jerome S. Mersenski, A. W. Perkins.

Mid-Michigan Section

Jack H. Anderson, Alfred Candelise, Harry J. Erickson, David M. Gurney, Robert E. Harris, William D. Wolfe.

Milwaukee Section

C. Richard Martin, Steve A. Ropar.

Montreal Section

Kristjan M. Oddson, Bernard C. Pilon.

New England Section

Robert G. DeSilverstri, Robert M. Oppenheimer.

Northern California Section

A. Fred Vetlesen, Arthur L. Lyman, Henry N. Mabery, B. F. Poduska.

Northwest Section

W. W. McFadzen, Richard W. Montague.

Philadelphia Section

Berton Karol, Ronald Kolenkiewicz, Charles B. Rawson.

San Diego Section

Donald A. Lang, Robert E. Radcliffe.

Southern California Section

William F. Ballhaus, John Cannon, Merle Alan Fillmore, William F. Gresham, Ervin F. Jensen, Richard M. Jones, Kenneth A. Lytle, Ernest P. Maurin, Jr., Arthur A. Nemechek, Jose Rosan, Jr., William L. Stabler, William K. Stevenson, Richard E. Tisch.

Southern New England Section

Frederick W. Gilbert, Martin J. Glenday, Glen A. Guernsey, Jack J. Lichtenberg.

Syracuse Section

William A. Kinnaman.

Texas Section

Martin G. Flood, Ben E. Poppe, Andrew C. Shafer, R. H. Williams, George R. Winkler.

Texas Gulf Coast Section

John A. Scofield, George A. Seipp.

Twin City Section

Wayne H. MacFarlane.

Virginia Section

Earlie S. Everhart, Jr.

Washington Section

Lewis R. Gober, Thomas T. Hinman.

Western Michigan Section

Will J. Squire, Lowell W. Syverson, Clifford J. Walsh.

Wichita Section

John J. O'Neill.

Williamsport Group

David I. Jenkins, Judd H. Lindauer.

Outside of Section Territory

Harold G. Houlton, Sven E. Johannson, E. F. Koenig, George L. McDonald, Harvey G. Patterson, Buster B. Poston.

Foreign

Archie L. Blackwood, India; L. G. Boehner, Germany; Vernon H. Farthing, England; Edwin J. Gartrell, Australia; Max B. Gratzl, Chile; Robert H. Jackson, India; Kenneth J. Mathieson, England; Leonard Andrew Paterson, England; Edward J. Rabson, England.

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- Challenging opportunities for fluid mechanics engineers in interesting research and development focused on, but not limited to, hydrodynamic propulsion, as well as broader fields of fluid mechanics.
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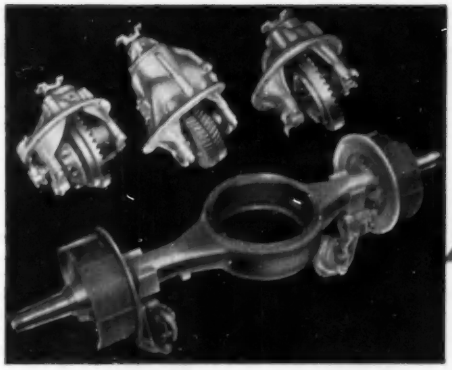
ORDNANCE RESEARCH LABORATORY

University Park, Pennsylvania

EATON AXLES

Proven Performance in Every Type and Size



The rugged housing used in famous Eaton 2-Speeds is also used for Eaton single-reduction and double-reduction axles—the three heads are interchangeable.

Behind every Eaton Axle there is almost a half-century of truck axle manufacturing experience. The advanced engineering and quality construction which have made Eaton 2-Speeds famous for stamina and low-cost hauling are also found in Eaton single-reduction, double-reduction, tandem drive axles, and front axles. In more than two million motor trucks, Eaton experience and engineering know-how are reflected in outstanding performance records, minimum hauling costs, and longer vehicle life.

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MANUFACTURING COMPANY
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PRODUCTS: Sodium Cooled, Poppet, and Free Valves * Tappets * Hydraulic Valve Lifters * Valve Seat Inserts * Jet Engine Parts * Rotor Pumps * Motor Truck Axles * Permanent Mold Gray Iron Castings * Heater-Defroster Units * Snap Rings Springtites * Spring Washers * Cold Drawn Steel * Stampings * Leaf and Coil Springs * Dynamatic Drives, Brakes, Dynamometers

LESS TORQUE

In leather—NATIONAL MICRO-TORC TRADEMARK

Lowest torque • Highest lubricity • No measurable leakage
Runs cool, lasts longer • Sealing lip stores oil

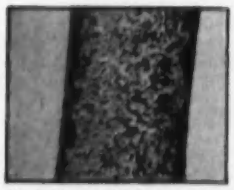

Fig. 1. National Micro-Torc Oil Seal. Oil cannot pass through elastomer coated side. Inner body retains natural porosity for "oil storage".

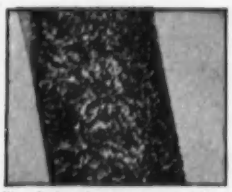

Fig. 2. Leather seal completely impregnated with rubber. Natural porosity of leather is destroyed by intense impregnation.

Shaft Size	Break Away Torque		Running Torque	
	Conventional Leather	Micro-Torc	Conventional Leather	Micro-Torc
1.500"	39 oz-in	7 oz-in	60 oz-in	56 oz-in
2.937"	126	39	253	144
3.812"	98	49	387	207

Fig. 3. Breakaway and running torque measurements, National Micro-Torc vs. conventional leather oil seals.

	NMB Micro-Torc		Completely Impregnated Leather Seal	
Test Conditions: Shaft Speed: Shaft Size: Shaft Runout, TIR: Oil Temperature:	2200 RPM 3.875" .003" 200° F.		800 RPM 2.750" .004" 165° F.	
Test No.	C-1642	C-1643	D-100	D-101
Total Running Time:	1017 hrs.	1017 hrs.	108 hrs.	108 hrs.
Condition after Test: Sealing Member: 180° Bend Test:	Flexible Surface Cracks	Flexible Surface Cracks	Very Stiff Deep Cracks	Very Stiff Deep Cracks

Fig. 4. Service life test results. National Micro-Torc Oil Seals vs. completely impregnated leather seals.

Revolutionary new Micro-Torc Oil Seals, exclusively from National, employ a leather sealing member coated on the surface with a high lubricity elastomer. This coating not only reduces torque as much as 80% but effectively prevents lubricant leakage. Since the coating is applied to the outer surface of the sealing member only, the body of the sealing lip retains its natural porosity to store oil for periods of semi-starved operation. (Figure 1.)

The appreciable superiority of Micro-Torc over completely impregnated leather seals (Figure 2) is shown at left. In addition to a marked reduction in torque (Figure 3), service life of Micro-Torc seals was test-proven to be up to 10 times the life of completely impregnated seals, and 2 to 3 times that of wax or resin impregnated seals. (Figure 4.)

In dry-running life tests Micro-Torc seals operated for 100 hours at 1,350 rpm *with no lubrication*. No squealing or sloughing was experienced, and all Micro-Torc seals remained flexible and operative.

National Micro-Torc Oil Seals are unaffected by many industrial fluids and lubricants which attack ordinary leather seals. They are recommended for application where temperatures do not exceed 200° F, shaft speeds are not over 2,000 fpm and runout is not greater than .005 indicator reading.

New! NATIONAL TORQUE METERS

New National Torque Meters provide a simple, accurate way to measure torque of oil seals. The meters are rugged, compact, easily portable, ideal for production line or receiving department. They have an easy-acting self-centering chuck for accurate seal holding, and use a simple taper-fitting test shaft you can make up in a matter of minutes. The Meters are designed for utmost simplicity, and with them unskilled personnel can make accurate torque readings with but a few moments training.

Two sizes: Model 615 fits seals up to 6" dia.; 15 lb. in. torque. Model 845 fits seals up to 8" dia.; 60 lb. in. torque.

Meters measure approximately 13" long x 10" wide x 11" high, weigh about 27 lbs. Sturdy carrying case can be furnished.

with NATIONAL OIL SEALS

In synthetic rubber—SYNTECH®

Low torque • Rubber-covered or ground O. D. • Long life
Zero leakage • Unaffected by most industrial fluids

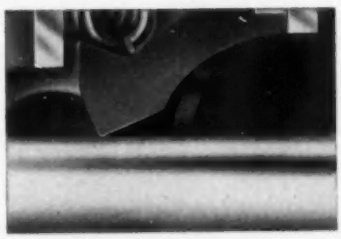

Fig. 5. Cross-section, typical National Syntech sealing lip. Note limited point of contact between seal and shaft.

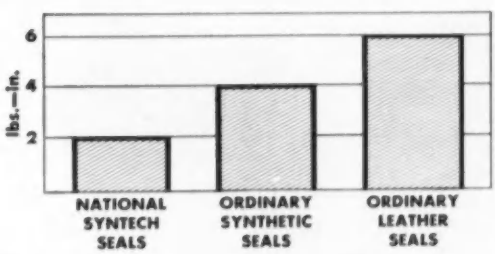

Fig. 6. Torque, Syntech vs. conventional synthetic rubber and leather oil seals. Seals tested on same shaft, under identical conditions.

Fig. 7. (Left) National Syntech Rubber-Covered O.D. (Right) National Syntech with machine-ground steel O.D.

Developed and introduced by National in 1946, National Syntech seals are among today's most widely used synthetic rubber oil seals. Their performance and dependability have been proven in thousands of commercial applications.

Syntech seals are particularly designed for higher speed, higher temperature applications where torque must be held to the absolute minimum. They feature an exclusive sealing lip design (Figure 5) which insures minimum contact between lip and shaft, yet provides zero leakage over a long service life. The marked difference in torque between Syntech and ordinary leather seals can be as much as 200%, as shown in Figure 6.

National Syntech Oil Seals are available in a wide selection of types and sizes, including seals with rubber covered or machine-ground peripheries (Figure 7) spring-tensioned or spring-less, or with twin or triple lips for special applications.

Call in a National Applications Engineer

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DEPT. C, REDWOOD CITY, CALIFORNIA

Please send complete information, illustrated technical details on
____ Micro-Torc seals ____ Syntech seals ____ Torque Meter

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3514

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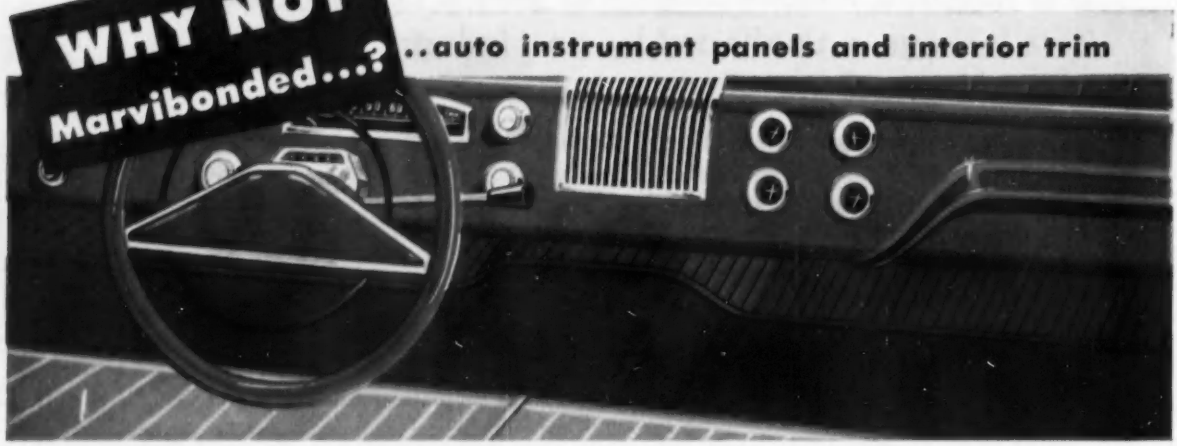
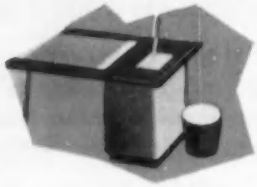
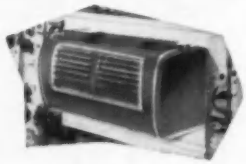


vending machine housings



waste baskets

business machine housings



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Sensational Piston Performance

UNIFORM CLEARANCE AT ALL TEMPERATURES

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Anchored only at pin bosses and cast in positive contact with I. D. of piston skirt

Controls Clearance Automatically

ZOLLNER CLEAR-O-MATIC PISTONS

Now, pistons may be fitted to closer clearances than ever before possible. The sensational development of CLEAR-O-MATIC Pistons by Zollner engineers *reduces required clearance to less than .001 with constant uniformity of skirt bearing over the entire temperature range.* Performance results are spectacular. Engines run quietly with no cold slap. Friction is reduced without loss of durability or heat conductivity. There is no danger of scuffing or seizing. The Zollner designed steel tension member incorporates in the aluminum piston the same effective expansion as the ferrous cylinder itself. We urge your immediate test of these sensational advantages for your engine.

Design adaptable to full skirted or slipper-type pistons for gasoline engines for every purpose.

UNIFORM EFFECTIVE SKIRT CLEARANCE AT ALL TEMPERATURES

1. Clearance maintained uniformly at all coolant temperatures from 20° below zero to 200° F.
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3. Steel tension member, with same effective expansion as cylinder, maintains uniform skirt clearance through entire temperature range.
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THE ORIGINAL EQUIPMENT PISTONS

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- ADVANCED ENGINEERING
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Heavy-Duty Mine Service Requires MECHANICS Quality

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You can rely on the same research that conceived, designed and developed the now famous and much imitated *Thin-Wall Babbitt bearing.

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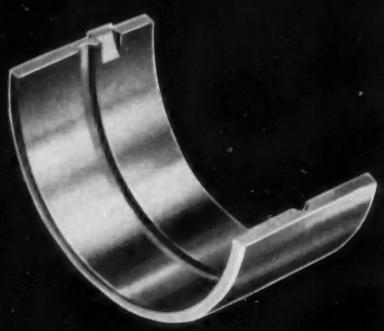

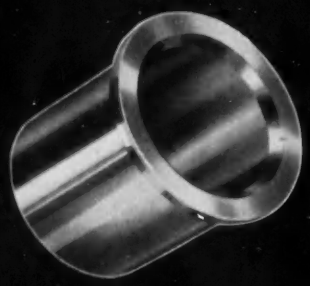

We can meet high production needs or special requirements for bearings and bushings of every type used in original equipment.

Steel backed, copper lead and aluminum alloy-lined bearings are lead-tin overplated to customer's specifications.

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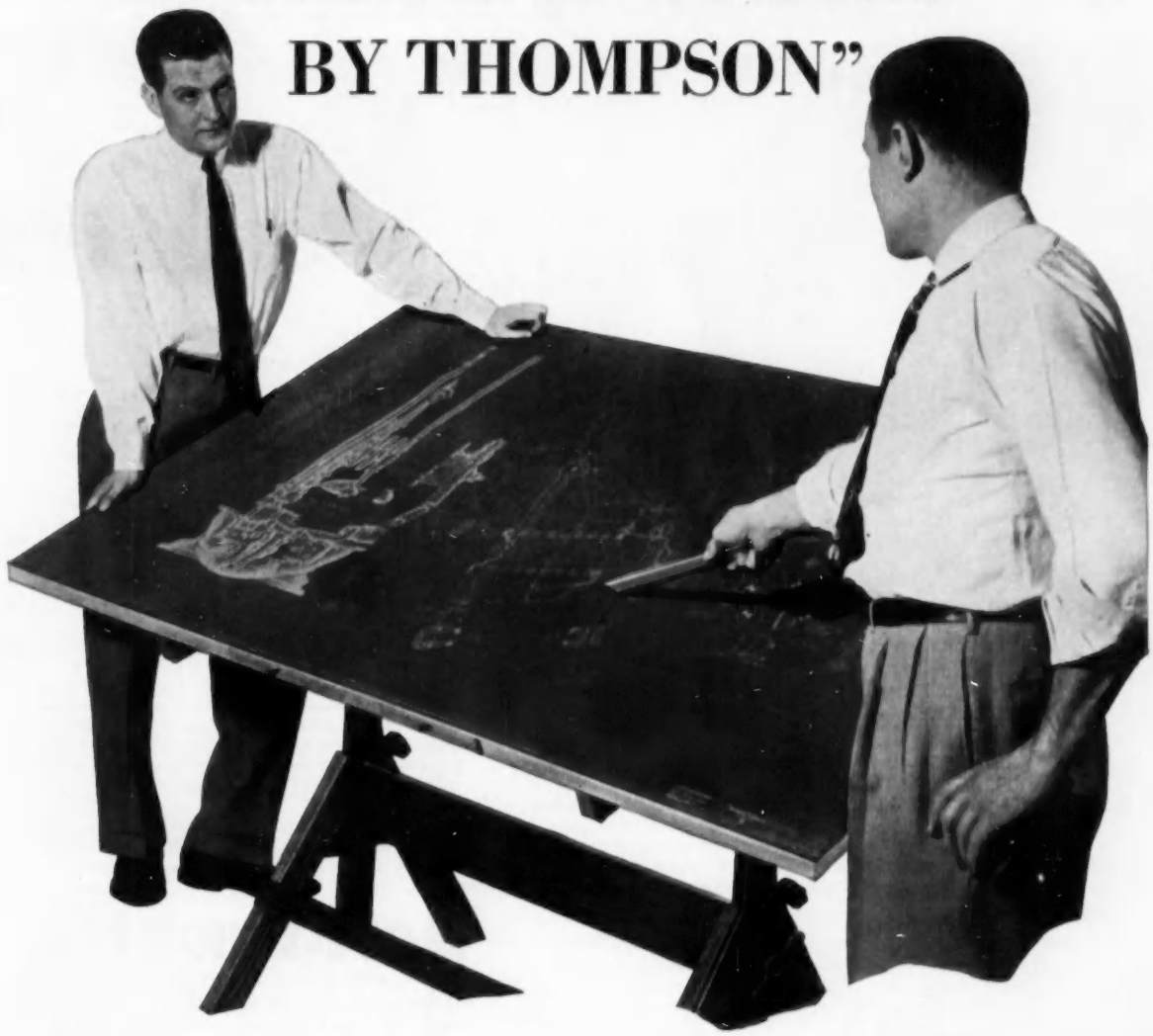

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Globe batteries give top performance...

ALL WAYS!

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That's why more and more automotive manufacturers are making Globe batteries *original equipment* on their products!

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To provide equipment that means more service for the buyer — and more satisfied buyers — install or specify Globe batteries. They're built better to serve better!

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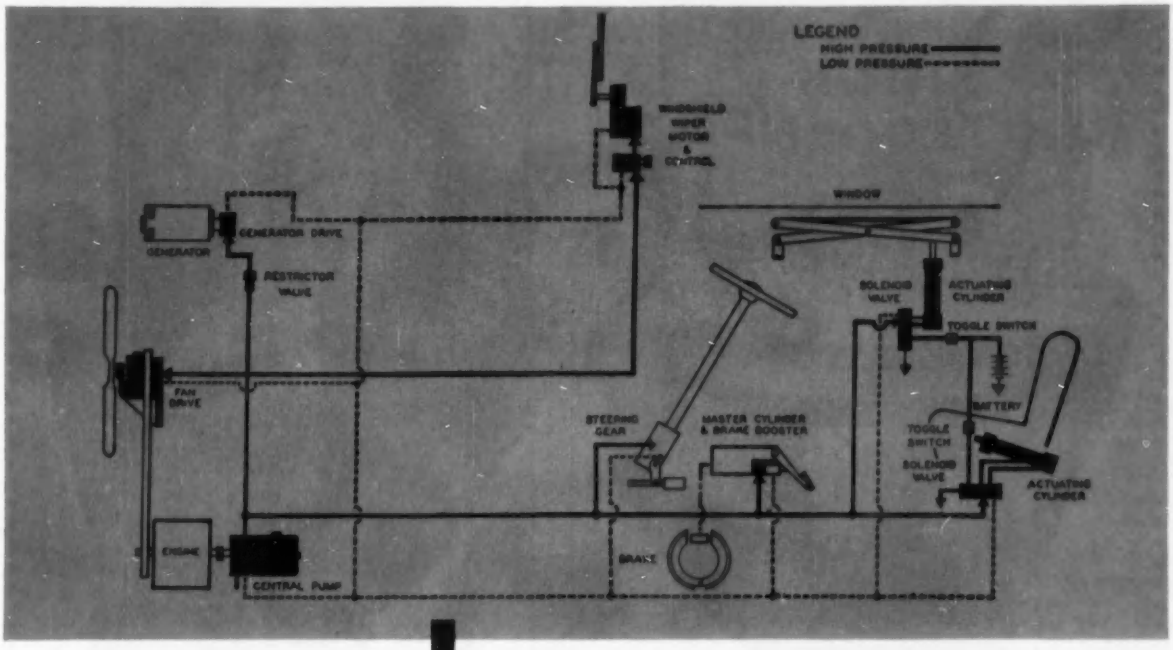
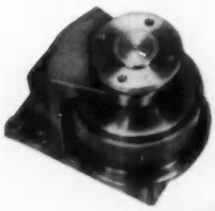
FOR FAST SERVICE THERE ARE 16 GLOBE BATTERY PLANTS — ATLANTA, GA. • BOSTON, MASS. • CINCINNATI, OHIO • DALLAS, TEXAS • EMPORIA, KANSAS • HASTINGS-ON-HUDSON, N. Y. • HOUSTON, TEXAS • LOS ANGELES, CALIF. • MEMPHIS, TENN. • MILWAUKEE, WIS. • MINERAL RIDGE, OHIO • OREGON CITY, ORE. • PHILADELPHIA, PA. • REIDSVILLE, N. C. SAN JOSE, CALIF. • AJAX (TORONTO) CANADA.

if it's petroleum-powered *there's a* GLOBE-BUILT BATTERY *...right from the start*

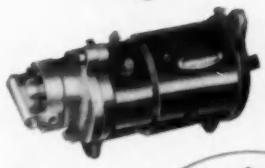
automotive central hydraulic system...



Power source is engine-driven, vane type Pesco Hydraulic Pump with variable volume output controlled by system demands. System pressure is constant.



Thermostatically controlled Hydraulic Fan Drive uses "on-off" operation for fast engine warm up and power savings.



Pesco Hydraulic Motor drives generator at constant speed permitting lower capacity, less costly generating system.

unique development uses one pump for all hydraulic requirements

Now, from Pesco comes an Automotive Central Hydraulic System to provide all hydraulic power requirements from a single pump source. This innovation eliminates use of multiple pumps, produces horsepower savings and permits use of a lower capacity electrical generating system.

The diagram shows that Pesco's simplified system provides dependable power-on-demand for operating fan, generator, steering mechanism, brake booster, windshield wipers, windows and seats. All or any part of the system may be incorporated to meet specific power requirements on passenger cars, trucks, off-the-road equipment and materials handling equipment.

Engineered and produced by Pesco, the Central Hydraulic System promises better operation and easier control of tomorrow's automotive equipment.

Sample units of the various components are available to the automotive industry for testing and can be supplied within a reasonable time. Pesco will provide full assistance in applying its system to your equipment. For detailed information, write: PESCO, 24700 North Miles Rd., Bedford, O.

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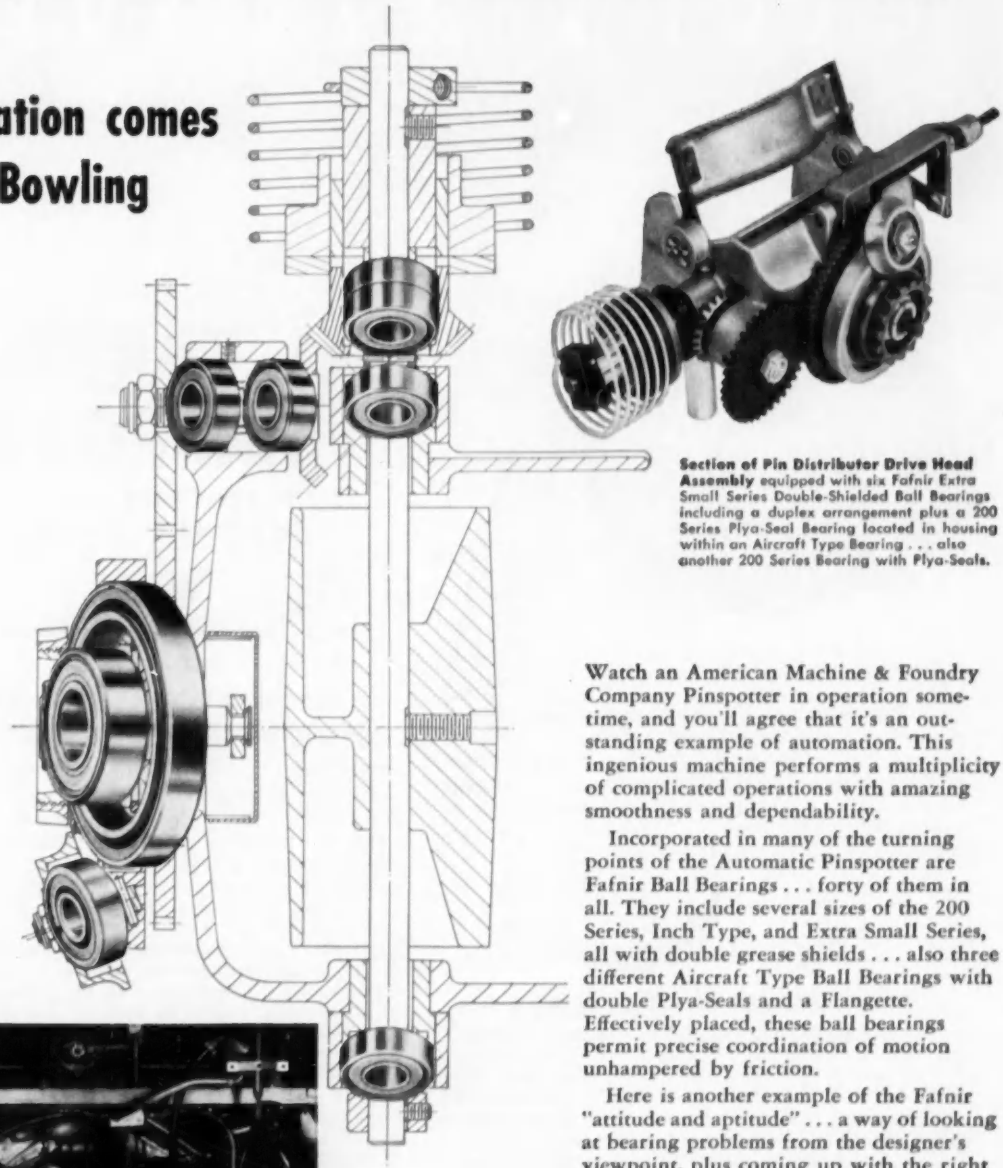
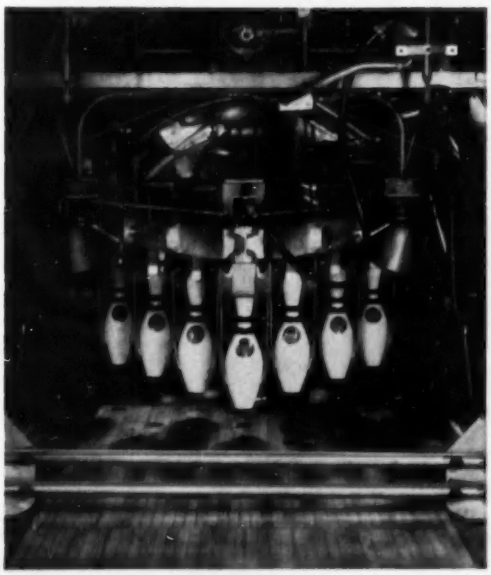
PUROLATOR PRODUCTS, INC., Rahway, New Jersey

Turning Points to more Efficient "Pin Boys"!

Automation comes to Bowling



Section of Pin Distributor Drive Head Assembly equipped with six Fafnir Extra Small Series Double-Shielded Ball Bearings including a duplex arrangement plus a 200 Series Plya-Seal Bearing located in housing within an Aircraft Type Bearing . . . also another 200 Series Bearing with Plya-Seals.



AMF Automatic Pinspotter is shown in process of lowering pins.

Watch an American Machine & Foundry Company Pinspotter in operation sometime, and you'll agree that it's an outstanding example of automation. This ingenious machine performs a multiplicity of complicated operations with amazing smoothness and dependability.

Incorporated in many of the turning points of the Automatic Pinspotter are Fafnir Ball Bearings . . . forty of them in all. They include several sizes of the 200 Series, Inch Type, and Extra Small Series, all with double grease shields . . . also three different Aircraft Type Ball Bearings with double Plya-Seals and a Flangette. Effectively placed, these ball bearings permit precise coordination of motion unhampered by friction.

Here is another example of the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the designer's viewpoint, plus coming up with the right bearing to fit the need. Automation problems and solutions are part of Fafnir's industry-wide experience. If you need the advantages of such experience, let Fafnir help you. The Fafnir Bearing Company, New Britain, Conn.

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BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

CONSERVATIVE

1955
The TURBO COMPOUND

5½ BILLION SEAT MILES IN 1954 WITH A PERFECT SAFETY RECORD

In the year just past, Turbo Compound-powered transports offered world travellers the advantages of 5½ billion seat miles of luxury service with perfect safety. The total is growing constantly. When present airline re-equipment programs are completed, 70,000,000 seat miles per day – over 25 billion per year – will be flown in transports powered by the Turbo Compound.

PROFIT POWER FOR THE WORLD'S FASTEST LONG-RANGE TRANSPORTS

Teamed with Lockheed Super Constellations and Douglas DC-7's, the Curtiss-Wright Turbo Compound engine has created a new reality of luxurious, high-speed transportation. Across all six continents and seven seas, this powerplant has telescoped time and distance, setting impressive records for speed with safety, and power with profit.

Such performance is a tribute to the engineering perception and skills that were able to harness exhaust gases formerly wasted in empty air – harness them to the Turbo Compound, and increase its horsepower by twenty percent without increasing fuel consumption!

SELECTED BY 30 LEADING WORLD AIRLINES PLUS THE MILITARY SERVICES

On the basis of proved performance under all conditions of climate and geography, these 30 leading world airlines have selected the Turbo Compound for their global routes. In addition, the Turbo Compound has been chosen by the U.S. Navy and the Air Forces of both the U.S. and Canada to power a wide variety of long-range aircraft that fortify America's defenses.

AIR FRANCE • AIR-INDIA INTERNATIONAL • AMERICAN AIRLINES • AVIANCA — COLOMBIAN NATIONAL AIRWAYS • B.O.A.C. — BRITISH OVERSEAS AIRWAYS CORPORATION • BRANIFF INTERNATIONAL AIRWAYS • CUBANA — CIA. CUBANA DE AVIACION, S.A. • DELTA-C&S AIR LINES • DEUTSCHE LUFTHANSA • EASTERN AIR LINES • IBERIA — AIR-LINES OF SPAIN • KLM — ROYAL DUTCH AIRLINES • LINEA AEROPOSTAL VENEZOLANA • NATIONAL AIRLINES • NORTHWEST ORIENT AIRLINES • PAKISTAN INTERNATIONAL AIRLINES • PANAGRA — PAN AMERICAN-GRACE AIRWAYS • PAN AMERICAN WORLD AIRWAYS • QANTAS EMPIRE AIRWAYS LTD. • SABENA • S-A-S — SCANDINAVIAN AIRLINES SYSTEM • SEABOARD & WESTERN AIRLINES • SOUTH AFRICAN AIRWAYS • SWISS-AIR • THAI AIRWAYS COMPANY, LTD. • TRANS-CANADA AIR LINES • TRANSPORTES AEREOS PORTUGUESES • TRANS WORLD AIRLINES • UNITED AIR LINES • "VARIG" BRAZIL.

This background of world-wide experience—combined with forward thinking that made the Turbo Compound the champion in its class – has now led to the concept of a new engine type which provides the richer resources of power needed for the sonic air age.

CURTISS-WRIGHT
CORPORATION · WOOD-RIDGE, N. J.

World's Finest Aircraft Engines

1960

The DE-RATED TURBOPROP

POWER, SAFETY AND PROFIT FOR THE NEAR-SONIC TRANSPORTS OF THE FUTURE

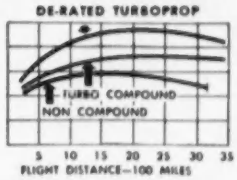
Across the continent in 5½ hours – across the Atlantic in 7½ hours – that is the promise of air transport by 1960. And for such performance, Curtiss-Wright has developed a new engine type – the DE-RATED TURBOPROP – to provide safe, conservative power for huge transports that will cruise at speeds of 500 miles per hour plus.

SAFETY The DE-RATED TURBOPROP was developed from the famous Curtiss-Wright J65 turbojet, with modifications that harness the engine's power to a propeller for greater efficiency. This engine is capable of developing horsepower far beyond the needs of the immediate future. Curtiss-Wright engineers have, therefore, "de-rated" the engine for commercial use – modified its design so that it operates at a conservative 60% of its real potential – with low stress and low operating temperatures for greater reliability. The result: a light, compact powerplant with impressive safety factors, low noise levels, proved components, and an earning capacity which out-distances that of any other engine type ever developed.

NOISE This is a smooth running, powerful turbine that will permit an airplane to take-off quickly and climb rapidly to cruising altitude resulting in a minimization of airport noise. The lower tip speed of the low activity propeller possible with this engine will also provide a quieter cabin during take-off and climb than that possible with other type engines. Thus, the type of conservative, foresighted planning that created the Turbo Compound fulfills in the DE-RATED TURBOPROP the needs of the future for greater speed, less noise, plus range and safety with payloads that pay a record breaking profit.

SPEED

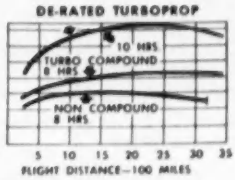
BLOCK-TO-BLOCK MILES PER HOUR



Four-engined transports with DE-RATED TURBOPROPS will fly in the near-sonic range of 500 miles per hour plus, giving them block-to-block speeds of over 475 miles per hour on flights of transcontinental length. This compares with block-to-block speeds of 375 miles per hour for Turbo Compound transports, and less than 300 miles per hour for non-compounded engines.

CAPACITY

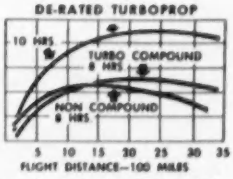
ANNUAL FULL LOAD TON-MILES PER PLANE



Because a typical four-engined transport with DE-RATED TURBOPROPS combines large payload capacity with near-sonic speed, it offers high utilization to the operator. For example, two transcontinental flights a day are possible with the same ship.

PROFIT

PERCENT OF PRESENT ANNUAL EARNINGS (60% FULL LOAD)



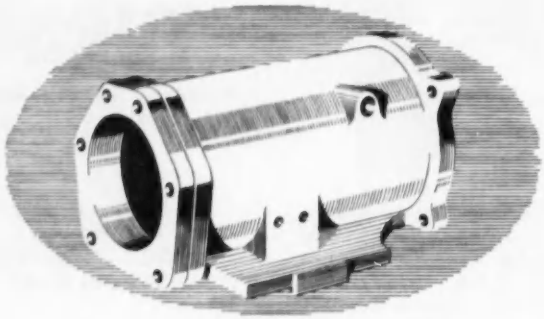
With high speed, payload and utility, the DE-RATED TURBOPROP-powered transport has a high annual revenue ton-mile carrying capacity resulting in a substantial increase in earning power (annual per plane).

CURTISS-WRIGHT

CORPORATION · WOOD-RIDGE, N. J.

World's Finest Aircraft Engines

How *ALCOA* would help you achieve the advantages of an *aluminum* transmission case



The other day a group of engineers from Detroit was looking over the facilities of our Cleveland Development Division. One of our visitors asked, "Suppose we were interested in developing an aluminum transmission case . . . how would you work with us?"

Because the answer explains so well how Alcoa works with the automotive industry, we present it here:

1. First we'd make sure that you knew the sound economic facts that suggest an aluminum transmission case. Weight reduction of 50 to 60 per cent compared to cast iron. Less load on the supporting structure. Easy machinability. Heat dissipation.

2. Then we'd suggest a joint meeting with your people to discuss your specific needs. The Alcoa engineers at the meeting would be men who know not only aluminum, but the ins and outs of transmission design.

3. Out of this meeting would come a definition of our joint responsibilities. Alcoa engineers would be assigned to explore in detail the adaptation of aluminum for your particular application.

4. Then design would start with your engineers supplying their detailed knowledge of your needs, your production processes and equipment—and ours supplying the practical solutions in aluminum.

5. We would suggest the Alcoa casting process best suited for the production of this part—an unbiased suggestion because we offer them all. But before making dies or molds, we'd make sand-cast samples for testing.

6. Both of us would want to give these castings the works in our test labs. Our own dynamometer, cold room and stress analysis equipment would be made available. You probably would want to add road tests. Any indicated changes in design would be made, new samples cast and the tests repeated. The first production castings from the die or mold would go through the same testing procedure.

7. We'd establish delivery dates you could count on for scheduling your assembly operations.

8. You'd get *quality* . . . very, very few rejects. We're able to enforce our quality rule because we have the most modern quality control devices in the industry.

* * *

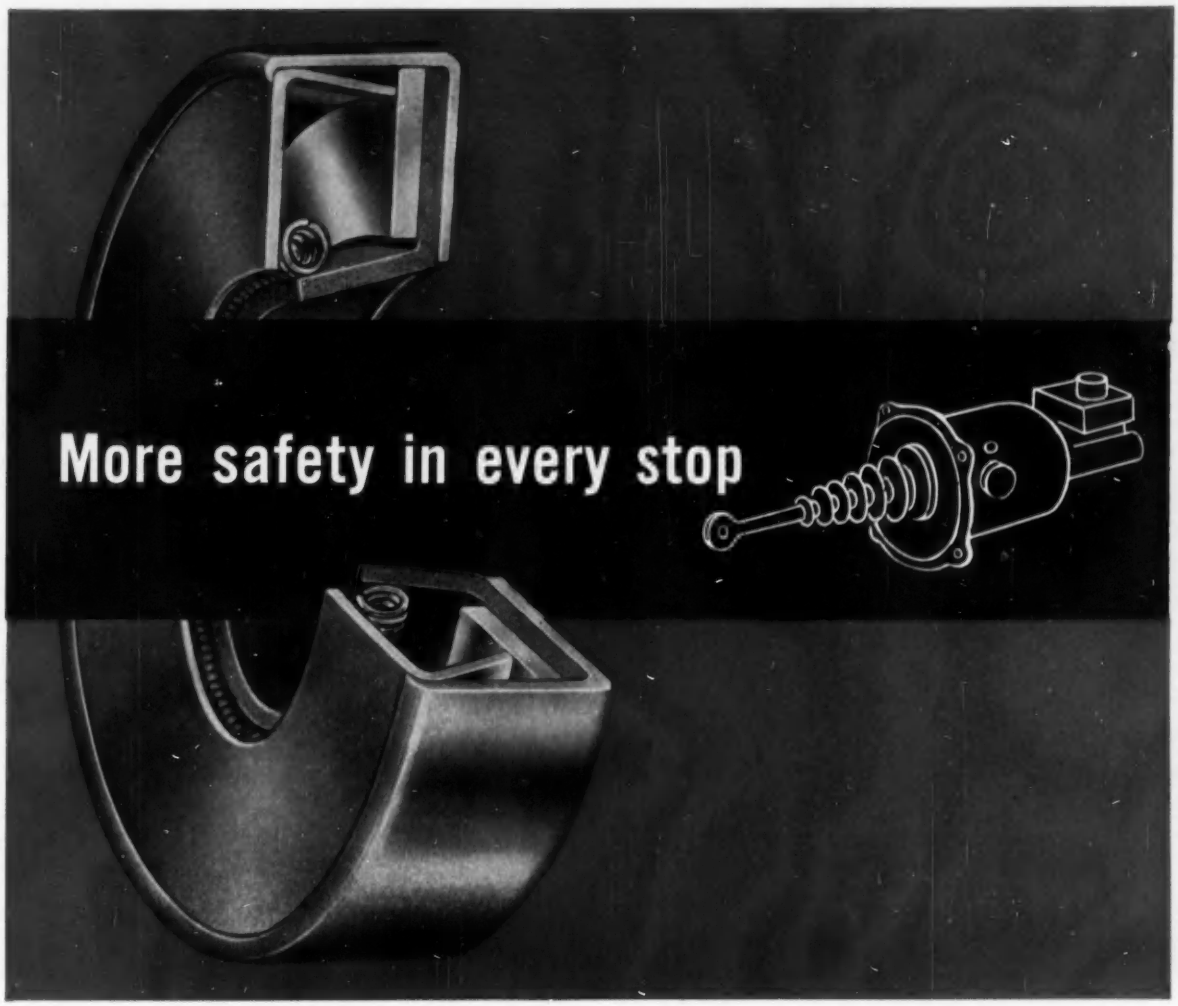
Let us prove to you the advantages of an Alcoa-cast aluminum transmission case. Talk it over with an Alcoa sales engineer. Have him put these facilities to work on your problem—that's what our Development Division is for! Aluminum Company of America, 1844-D Alcoa Building, Mellon Square, Pittsburgh 19, Pa.

YOUR GUIDE TO ALUMINUM VALUE

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

Fasten Aluminum With Alcoa® Aluminum Fasteners



C/R SEAL BACKS UP EXTRA BRAKING POWER

Every time you touch your brake pedal it must function dependably. In a well-known power brake unit a small back-up seal is doing a big job—providing an extra margin of safety. It's a C/R Oil Seal used between the vacuum and hydraulic cylinders. The sealing element had to be designed to exacting requirements. It seals effectively on both sides, withstands pressures to 10 psi, and provides maximum flexibility to follow possible eccentricity up to .025". In thousands of applications there has never been a failure.

If your product must conform to equally high standards of performance, consider C/R Oil Seals. You may choose from 17 stock types in over 1800 sizes, or work with C/R engineers on special designs. For basic information let us send you a copy of "C/R Perfect Oil Seals."

C/R PERFECT Oil Seals

More automobiles, farm equipment and industrial machines rely on C/R Oil Seals than on any similar sealing device.

CHICAGO RAWHIDE MANUFACTURING COMPANY

1301 Elston Avenue OIL SEAL DIVISION Chicago 22, Illinois

IN CANADA: SUPER OIL SEAL MFG. CO., LTD., HAMILTON, ONTARIO

Other **C/R** *products*

SIRVENE: (Synthetic rubber) diaphragms, boots, gaskets and similar parts for critical operating conditions • CONPOR: Controlled porosity mechanical leather packings and other sealing products • SIRVIS: Mechanical leather boots, gaskets, packings and related products.

Matched to your toughest conditions

Steep grades! Heavy loads! Tough muddy going! The most adverse conditions are duplicated in our "Torture Chamber" to produce an axle tailored to *your special needs*. Stock axles are picked at random and subjected to tests the equivalent of a "chuckhole" shock every 4 seconds, 24 hours a day, for months on end. Another test simulates an uphill pull all the way from New York to California. Only tests as rugged as these could produce axles so tough.

GREATEST ADVANCE SINCE

exclusive double-reduction design 2-speed gear ratio spread!

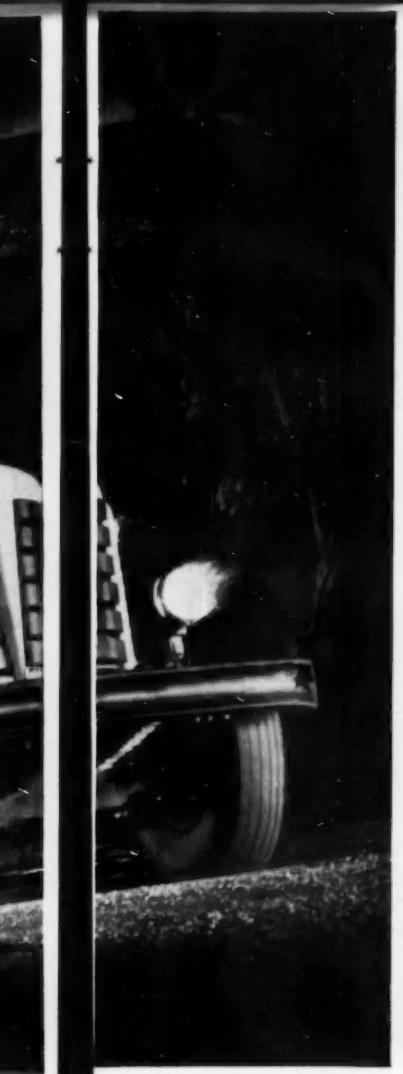
Tailor-made power exactly to your trucking needs with Timken-Detroit!

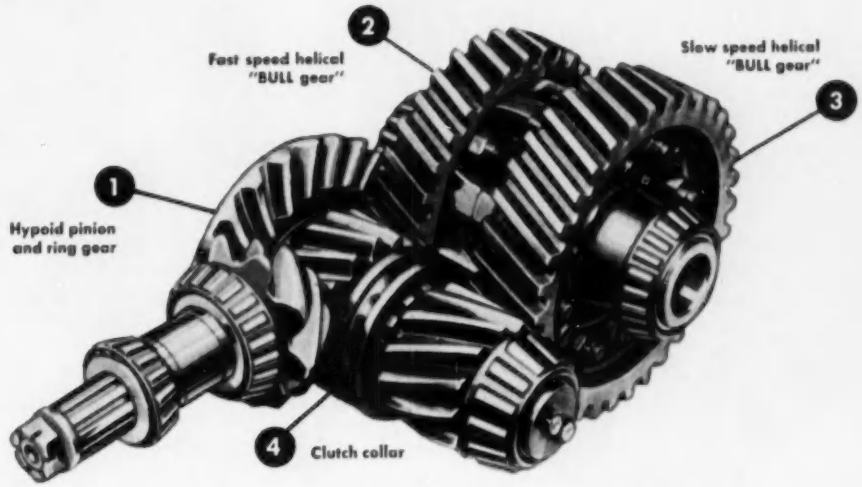
Unequalled flexibility! TDA 2-Speed Axles, give an almost *unlimited* choice of gear ratios. The Timken-Detroit design is so simple and basic, that an ordinary mechanical change lets you tailor power exactly to your trucking needs. Where other 2-speed axles limit you to only a single gear spread of 37%, TDA offers a range all the way from 28% to 49%.

TDA meets varied needs! The variety of hauling conditions that today's trucks must meet call for maximum speed and power flexibility. Other 2-speed axles are just too limited to meet this need. On the other hand, TDA's simple double reduction design gives complete flexibility. Gear ratio can be easily changed without weakening the axle unit in any way.

How you benefit! TDA not only gives you a much wider power range, but also, all the advantages of a stronger, sturdier, smoother operating design. Since helical "Bull" gear sets operate independent of one another, there is no overheating even after indefinite running in low speed. Bigger huskier TDA parts last longer, stand up better under tough usage.

Less down-time, longer axle life, fewer repairs, higher fuel economy, lower operating costs and higher profits. These are some of the important reasons why so many leading manufacturers and operators everywhere specify Timken-Detroit 2-Speed Axles.





How the exclusive double-reduction design of

TDA 2-SPEED AXLES

gives you greater speed, endurance, and economy!

This is HOW TDA's 2-Speed principle works! A husky hypoid ring gear and a bigger, stronger pinion set (No. 1 in illustration above) provide the *first step* of the total gear reduction for both fast and slow ratios. Two large, heavy-duty helical gear sets provide the *second step*. Both sets are of balanced size and capacity. One set (No. 2 in illustration) is for fast speed; the other (No. 3) is for slow speed. The clutch collar (No. 4) moves to right or left to engage one helical pinion or the other.

WHY this principle offers far wider spread! Because the TDA design is so simple, the ratio may be changed merely by changing the low speed helical gear pinion. Unlike ordinary designs which are limited to 37%, TDA offers spreads of 28%, 37%, and 49%. In effect, this flexibility gives you your choice of power ratios to exactly match your needs.

Greater endurance, longer truck life with TDA. TDA's simple design eliminates small complicated parts and midget size gears. Large hypoid helical design gives more teeth in contact – quieter operation and far less strain. Bearings are larger, too. Helical "Bull Gears" not in use idle, further reducing wear. All this adds up to longer engine life... and more efficient and profitable operation under all conditions.

THE FIRST 2-SPEED AXLE

gives TDA world's widest

TIMKEN Detroit AXLES

TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

"Accepted" TDA "Standard"
TRADE MARK REGISTERED

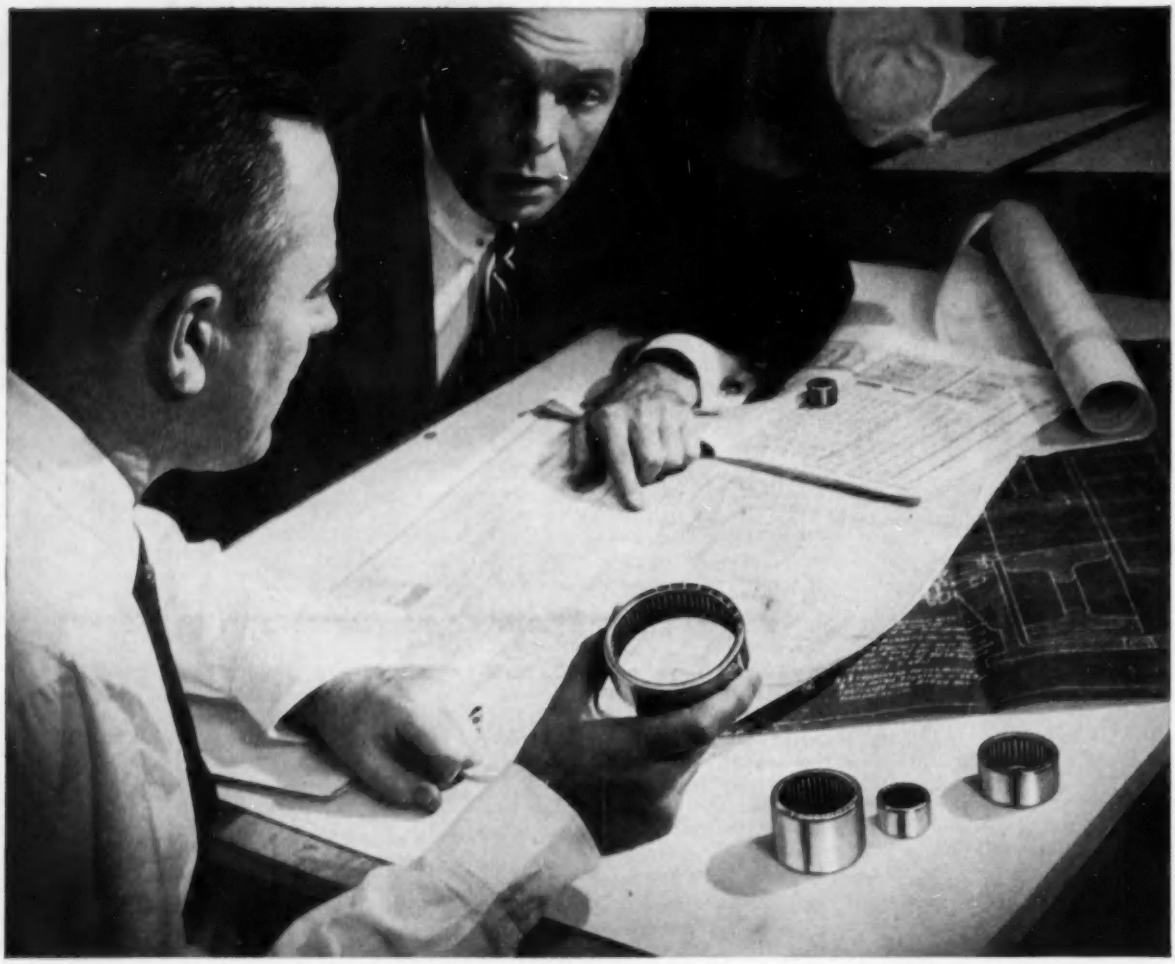
World's Largest Manufacturers of Axles for Trucks, Buses and Trailers

Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York • Ashtabula, Kenton and Newark, Ohio New Castle, Pennsylvania

Increase axle life with GENUINE TDA EQUIPMENT PARTS

Take no chances with ordinary replacement parts. For sure, dependable factory-type jobs, specify genuine Timken-Detroit axle parts kits—identical to your axles' original equipment.

Each kit is complete — gives you everything you need in one handy package. Gaskets and shim parts, brake liners, steering knuckles, differential gears — for every size of brake and axle. Order by number from your dealer. Cut labor and adjustment costs. Get trucks back on the road quicker.



His wide experience with **TORRINGTON NEEDLE BEARINGS** may solve *your* problem

Here is a Torrington Staff Engineer working on a new application for Torrington Needle Bearings.

He's made a thorough study of the field report from the District Engineer. He's consulted the files for similar applications—files which comprise the complete history of Needle Bearing applications to date. He's talked with—and may even have worked with—the customer's own design staff. Now he's back at his board with the Chief Bearing Engineer after he has carefully analyzed speeds, loads and deflections.

This product could be yours. The unmatched experience in Needle Bearing applications of our Engineering Department can be brought to bear on your anti-friction bearing problems. And you can gain for your product the unique advantages that the Needle Bearing has given to thousands of products throughout industry in the past twenty years. Let us help you make the Needle Bearing "standard equipment" in your product.

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON *NEEDLE* **BEARINGS**

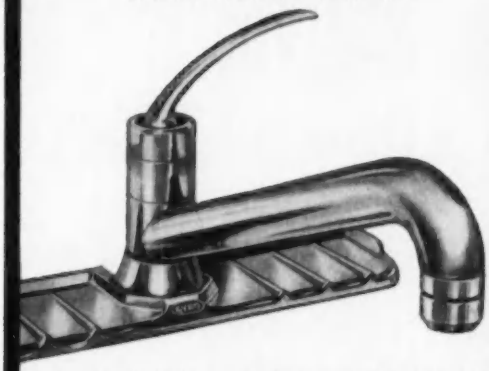
Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

These features make the **TORRINGTON NEEDLE BEARING** *unique*

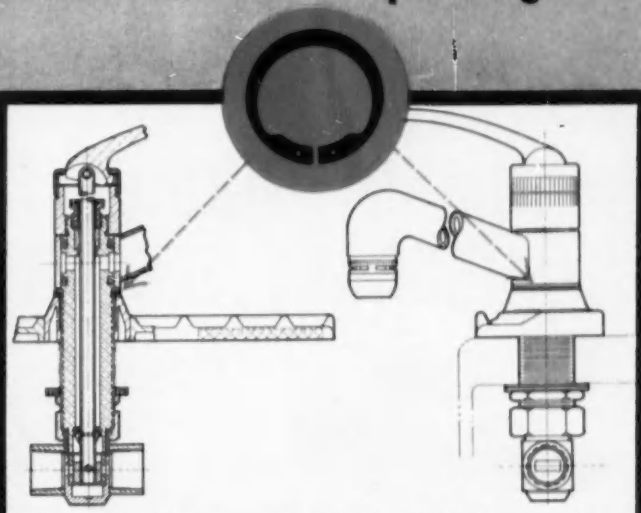
- low coefficient of starting and running friction
- full complement of rollers
- unequalled radial load capacity
- low unit cost
- long service life
- compactness and light weight
- runs directly on hardened shafts
- permits larger and stiffer shafts

Waldes Truarc ring reduces valve body from 1 5/16" to 1 1/16", eliminates chrome plating

GYRO MIXING FAUCET



Single-handle kitchen mixing faucet controls hot and cold water, as well as volume. Radical design has no seals or spindles to replace. One Waldes Truarc retaining ring allows complete assembly and disassembly from either top or bottom of unit.



Aluminum Truarc Ring (external inverted Series 5108) acts as bearing retainer, insures precise alignment of spout and escutcheon, gives uniform shoulder with machining. Truarc ring provides shoulder that would otherwise require machining valve body to 1 5/16" against 1 1/16" used. Also eliminates expensive chrome plating of valve body.

Gyro Brass Manufacturing Corporation of Westbury, L. I., N. Y., uses a single Waldes Truarc retaining ring (Series 5108) both as a positioner and retainer on their Gyro Mixing Faucet. Aluminum Truarc ring not only eliminates expensive machining, but also does away with a chrome plating process that would be necessary if the shoulder were made of the solid material of the body.

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered...quick and easy to assemble and disassemble.

More than 5,000 stock sizes of the different Truarc ring types available. Ninety stocking points throughout U. S. A. and Canada.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES
TRUARC®
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name.....
Title.....
Company.....
Business Address.....
City.....*Zone*.....*State*.....

SA-057

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

Complete facilities for design, development and testing of your special aircraft accessories or systems . . . plus production for limited or full-scale runs. Write to Jack & Heintz, Inc., 17638 Broadway, Cleveland 1, Ohio. Export Department: 13 East 40th Street, New York 16, N. Y.

©1955, Jack & Heintz, Inc.

JACK & HEINTZ *Rotomotive* AIRCRAFT EQUIPMENT

Fewer tools, lower costs, no rejects ...with Tinnerman SPEED NUTS!

A change to Tinnerman SPEED NUT brand fasteners can eliminate production problems in addition to saving important assembly dollars! Here's proof. The Peterson Manufacturing Company, Kansas City, Missouri, formerly assembled its Combination Stop and Tail Lamp with four stamped and tapped brackets. Costly equipment was necessary to manufacture the brackets, and misalignment of holes often made assembly difficult. Damage to units on the assembly line averaged 5%!

Four SPEED NUTS have changed everything! Material costs have been cut a whopping 60%! The tools to manufacture the brackets are eliminated. The easy lead-in provided for screws by the SPEED NUT impression cuts assembly time 20%, increases production by 15%. Misalignment of holes presents no problem for SPEED NUTS and assembly-line damage is completely eliminated!

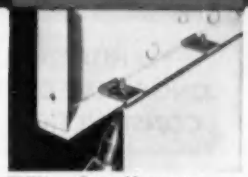
Let Tinnerman help with your fastening problems. Ask your Tinnerman representative or write for complete details on our Fastening Analysis Service.

TINNERMAN PRODUCTS, INC. • BOX 6688, DEPT. 12, CLEVELAND 1, OHIO

Canada: Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

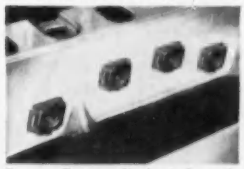
TINNERMAN Speed Nuts® FASTEST THING IN FASTENINGS®

TYPICAL USES



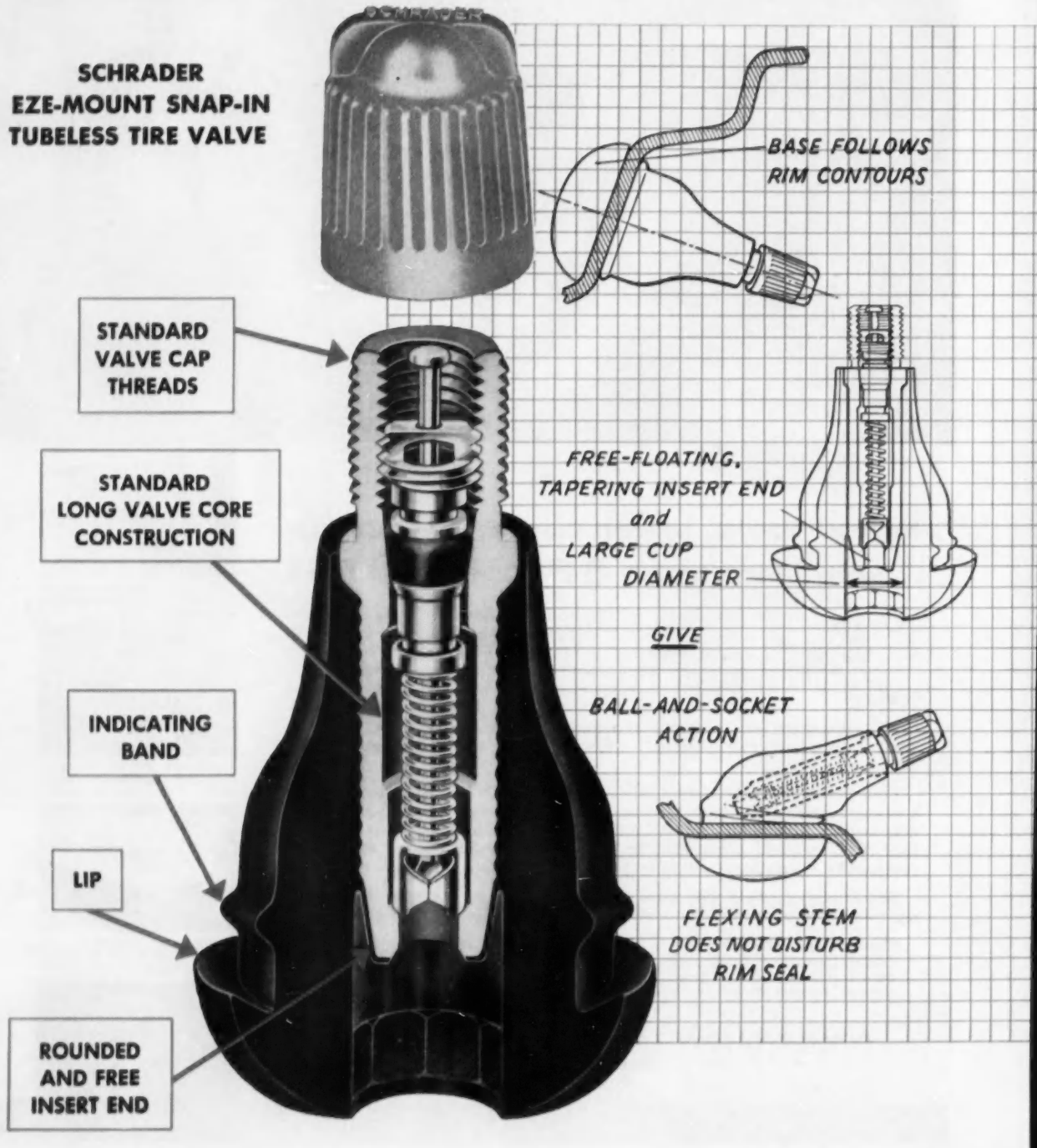
"U" type SPEED NUTS cut assembly costs, maintenance on farm equipment.

Special SPEED NUT eliminated production problems on washing machine motor mount bracket.



SPEED GRIPS eliminated costly repairing of truck radiators returned because of weld breaks.

NOW BETTER SCHRADER EZE-MOUNT



THAN EVER!
TUBELESS TIRE VALVE

EASY INSERTION—EZE-MOUNT Tubeless Tire Valve is specially designed and shaped so that gradual tapering rubber cover stretches for easy insertion into the rim—then expands for tight seal.

SURER, SAFER SEAL—Full diameter base with special lip, enlarged hole and shortened insert, permit better seal of valve to rim. Lip provides further adjustment to various rim contours.

FIELD SERVICE SIMPLIFIED—Easier-than-ever field service. Special band molded on shank shows when valve is sealed to the rim. Replaceable parts are the same time-saving standard type used since the first automobile.

"BALL-AND-SOCKET" ACTION—When valve is inserted in rim hole, special construction of metal insert, plus enlarged valve base hole, permits "ball-and-socket" flexibility. This keeps base stationary when top of stem protruding from rim hole is distorted by air chuck, gauge, or road hazards.

EZE-MOUNT WORKS WITH THE SCHRADER STANDARD LONG CORE CONSTRUCTION

Talk about design features! Schrader has them all. Look how the EZE-MOUNT Tubeless Tire Valve snaps in . . . to stay! And how it gives greater flexibility . . . stays sealed to the rim when stem is flexed. All this with the famous Schrader "Ace of Standardization" long core principle of Tire Valve construction—time-proved to be the best way to control air in any pneumatic tire.

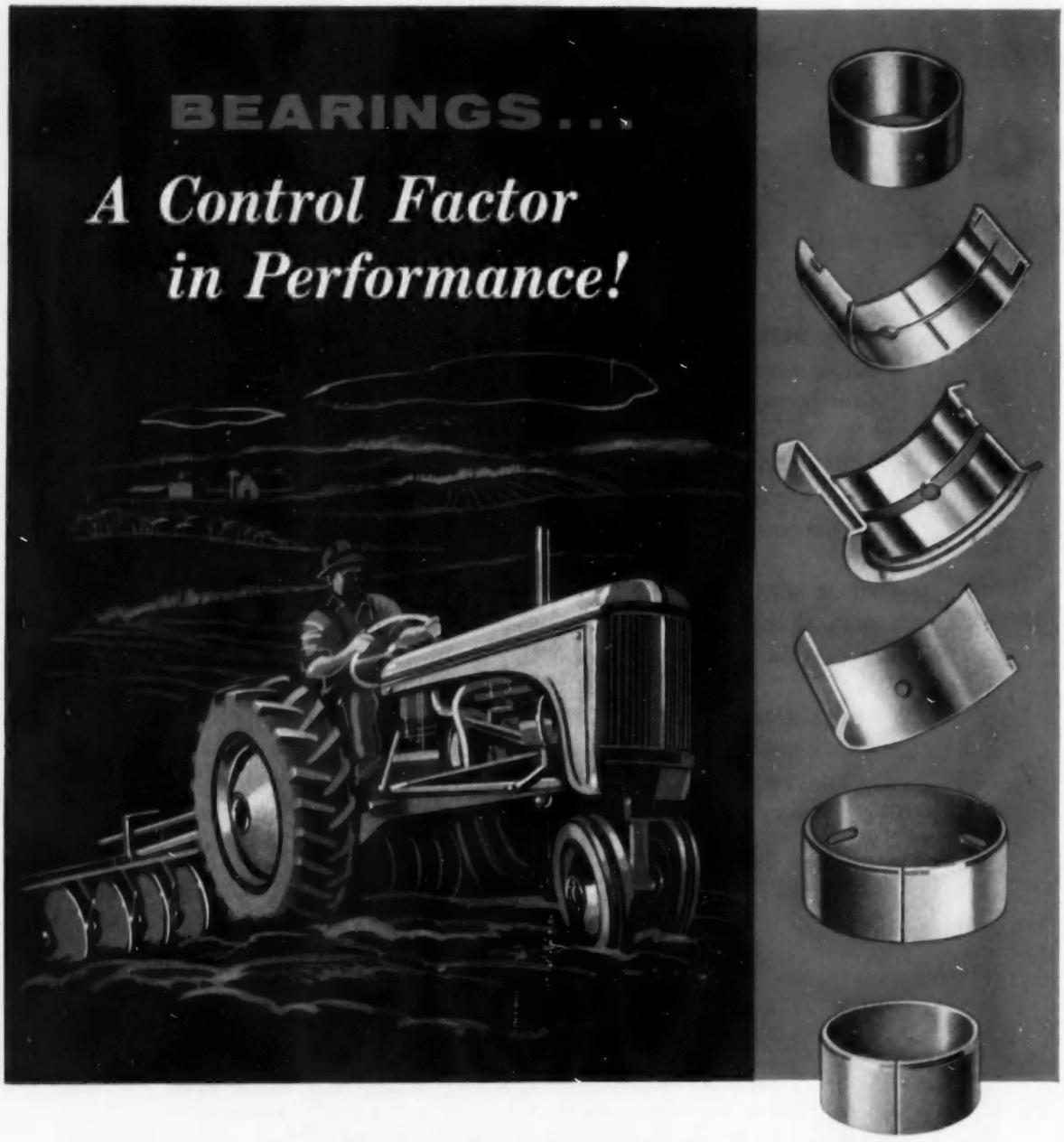
And important to you, too, aside from providing this valve for Original Equipment on new cars—Schrader provides this same EZE-MOUNT Valve and the mounting tools* to make field service fast, easy—economical.

*Brochure upon request.

A. SCHRADER'S SON
Division of Scovill Manufacturing Company, Incorporated
470 Vanderbilt Avenue, Brooklyn 38, New York

Schrader
REG. U. S. PAT. OFF.

FIRST NAME IN TIRE VALVES
FOR ORIGINAL EQUIPMENT AND REPLACEMENT



RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

Farm tractors give engine bearings a tough test. It's a matter of heavy-load engine operation through long hours in dusty fields . . . and the bearings *have to "take it!"* For quality and dependability, Federal-Mogul engine bearings and bushings are used by many leading manufacturers of farm tractors. Our engineers have specific answers to such application problems. Your inquiry is invited. Federal-Mogul Corporation, Detroit 13, Mich.

SINCE 1899

FEDERAL-MOGUL

FEDERAL Mogul

Riss Buys 500 ROADRANGERS®

Riss & Company, Inc. of Kansas City, Mo., specified that every one of their new fleet of 500 tractors be *equipped with a Fuller Semi-Automatic R-950-C* ROADRANGER *Transmission.*

With *single*-lever control of all 10 forward speeds, the Fuller ROADRANGERS permit Riss drivers to *anticipate grade requirements* and meet them with the right ratio at the right time. The ten closely spaced ROADRANGER gear ratios can be readily anticipated and rapidly engaged, without having to wrestle with gear splits or wait for automatic actuation. And with all forward ratios in even 28% steps, they can match power precisely to load and grade demands and at the same time save fuel by keeping the engine operating in the maximum horsepower range.

• • •

For the most efficient, easiest-shifting transmissions available today . . . *specify Fuller Semi-Automatic* ROADRANGERS *for your fleet!*

FULLER MANUFACTURING COMPANY
(Transmission Division) Kalamazoo, Mich.

Fuller TRANSMISSIONS®

Unit Drop Forge Div., Milwaukee 1, Wis. • Shuler Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest Dist. Office, Tulsa 3, Okla.

HOW R/M ENGINEERING SETS

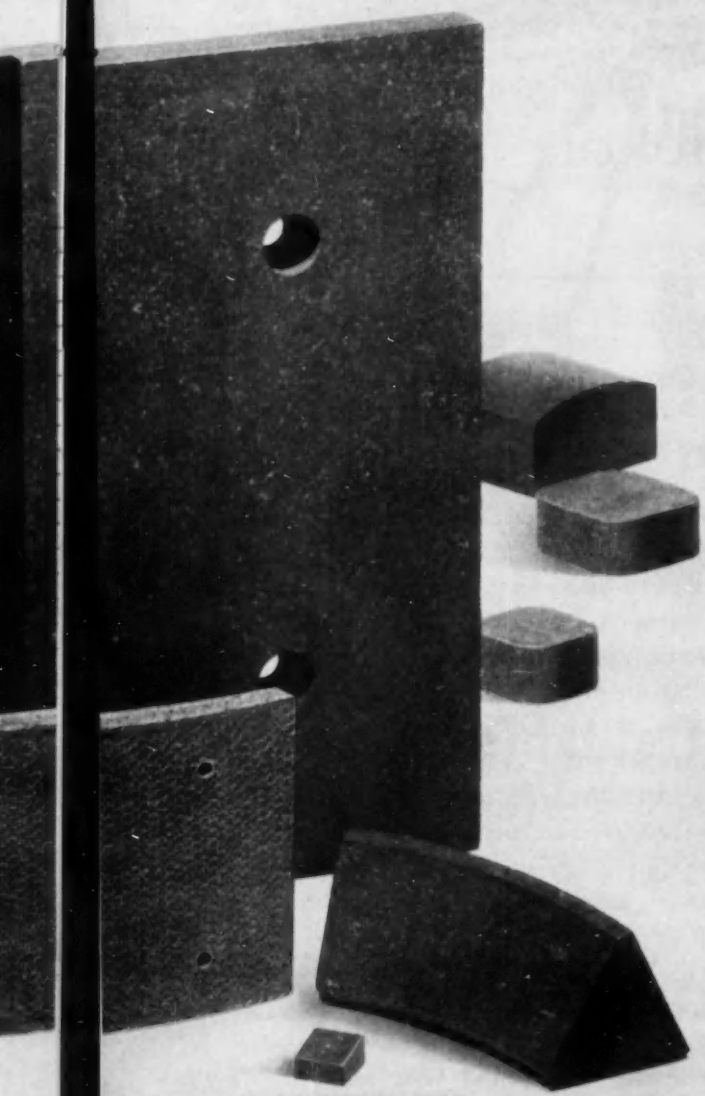
R/M
FIRST IN FRICTION

Illustrated here are just a few of the brake blocks R/M manufactures for automotive and industrial use. The full list would include hundreds, differing not only in size and shape but in performance characteristics as well.

THE RECORD OF "FIRSTS" IN FRICTION MATERIAL DEVELOPMENT SHOWS WHY R/M IS FIRST IN FRICTION

FIRST Woven Brake Lining • FIRST Asbestos Brake Lining • FIRST Ground Wearing Surface • FIRST Zinc Alloy Wire Brake Lining • FIRST Pre-Treated Yarns • FIRST Extruded Pulp Brake Lining • FIRST Flexible Pulp Brake Lining in Rolls • FIRST Dry Process Brake Lining • FIRST Semi-Metallic Brake Lining • FIRST Bonded-to-Metal Brake Lining • FIRST Woven Clutch Facings • FIRST Molded Asbestos Clutch Facings for Clutches Operating in Oil FIRST Endless Woven Clutch Facings • FIRST Pre-Treated Clutch Facings • FIRST Bonded-to-Metal Clutch Facings

THE PACE IN FRICTION MATERIAL DEVELOPMENT



BRAKE BLOCKS

Ever seen a brake block 3 feet long—and 5 inches thick? R/M makes this giant with the same skill and precision used to turn out a friction part for ordnance that's smaller than a pencil eraser.

Whatever your requirements for buses, trucks or heavy industrials, there is no brake block size or type R/M can't produce to help you meet them exactly.

Raybestos-Manhattan has been the world's largest maker of friction materials for over 50 years. In this time, R/M has acquired a fund of knowledge and experience second to none in the industry.

For example, just since 1947, four bus fleets in continuous field testing of R/M brake block materials have covered a total of 3½ million miles. And on some of the world's largest and most versatile dynamometers, R/M engineers are exploring the fade, recovery and other characteristics of different brake blocks and combinations in a continuing search for friction materials of greater output and greater durability, and at a lower price.

Type of drum the brake block works against, temperature range the block must work in, and general friction range required are all factors that affect brake block performance. R/M's knowledge of how and why have already enabled us to solve friction problems you may be facing now.

Only R/M Works with All Friction Materials

To meet your specific design and operating requirements, R/M offers the widest range of friction materials in the industry. Unlike most other manufacturers, R/M works with *all kinds* of friction materials. That's why, when you consult an R/M Engineer, you can be sure of completely unbiased, impartial advice on which materials or combinations of materials are best for your purpose.

Whether your product requirements are for brake blocks, brake linings, clutch facings, or any other friction part, it will pay you to talk to Raybestos-Manhattan now. All of the facilities of R/M's seven great plants, with their research and testing laboratories, and all of R/M's experience, are as near as your telephone.

Write for your free copy of R/M Bulletin No. 500. Its 44 pages are loaded with practical design and engineering data on all R/M friction materials.

R/M
FIRST IN FRICTION

THE TRADE-MARK THAT SPELLS PROGRESS IN FRICTION MATERIAL DEVELOPMENT

RAYBESTOS-MANHATTAN, INC.

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Canadian Raybestos Co. Ltd., Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Industrial Rubber, Engineered Plastic, & Sintered Metal Products • Rubber Covered Equipment • Asbestos Textiles • Packings • Abrasive & Diamond Wheels • Bowling Balls

IX

This is the ninth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

The Effect of Nickel in Alloy Steels

Each element in an alloy steel has its own particular job to do, and each is included with a special purpose in mind. What are some of the reasons, say, for using nickel, chromium, molybdenum, vanadium, and other components that appear in the various analyses? The elements in any alloy steel work both individually and as a team. What does each one do? In this and subsequent discussions we shall try to answer these questions, beginning with nickel, one of the fundamental alloying elements.

Nickel increases toughness and resistance to impact, particularly at low temperatures; lessens distortion in quenching; improves corrosion-resistance. It lowers the critical temperatures of steel and widens the temperature range for successful heat-treatment.

Nickel steels are particularly suitable for case-hardened parts, such as aircraft-engine gears and roller bearings. Such steels provide strong, tough, wear-resistant cases and also ductile core properties.

Advantages imparted by nickel are not restricted to quenched-and-tempered steels. Nickel often permits given strength levels to be obtained at considerably lower carbon contents, thereby markedly increasing toughness, plasticity, and fatigue-resistance. Nickel steels are therefore highly suitable for applications where liquid quenching is not employed, such as high-strength structural steels used in the as-rolled condition or heavy forgings not adapted to quenching. Products of this nature must develop superior properties after nothing more severe than air-quenching treatments.

If you would like to know more about nickel steels, or need information about other types of alloy steels, please feel free to consult with Bethlehem's metallurgists. These technicians will gladly advise you regarding analyses, heat-treating, machinability, etc. You are invited to make use of their services whenever you need assistance.

And may we remind you, too, that Bethlehem makes all AISI standard alloy steels, as well as special-analysis steels and the full range of carbon grades. We are always in a position to meet your needs promptly and fully.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

In the new IH truck with Metro-Lite body

VIBRIN... for moldable, lightweight strength!

The custom-made Metro-Lite* body places unusually high demands on the materials used. They have to be strong, light, and *easily fabricated*... and where curved components are necessary VIBRIN is used for International multi-stop trucks with these special bodies.

NAUGATUCK'S REINFORCED VIBRIN POLYESTER *IS*...

STRONGER THAN STEEL! Reinforced VIBRIN can actually be made stronger than steel by weight.

LIGHTWEIGHT! Reinforced VIBRIN is one of the lightest materials you can use... helped International attain cut-backs in weight of nearly 800 lbs.

EASILY FABRICATED! Complex, multiple curves are easily molded all in one operation.

DENT-PROOF! Reinforced VIBRIN has unusually high impact strength. And, sections that are subject to heavy road shock or impact damage can be easily strengthened by area reinforcement.

RUST-PROOF, ROT-PROOF! VIBRIN is highly resistant to abrasion, to grease, oil, and most chemicals—it is not damaged by climate or temperature extremes.

STRUCTURALLY STABLE! Reinforced VIBRIN won't warp, shrink, or lose its fit.

EASILY PIGMENTED! VIBRIN parts may be permanently colored. When painted the same color, scratches and chips do not show through.

HIGHLY FINISHED! The finish is imparted by the mold—there is no expensive make-ready prior to painting.

With all these qualifications it's no wonder more and more manufacturers are swinging to VIBRIN®. Would you like to find out how this unique plastic can put *you* on the road to more profits? Write to us on your company letterhead, TODAY!

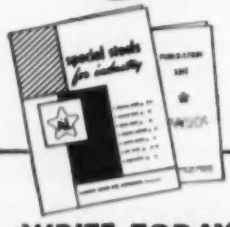
*A modern lightweight truck body now being produced by THE METROPOLITAN BODY COMPANY, Bridgeport, Conn., subsidiary of International Harvester Co.

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • Memphis • New York • Philadelphia • IN CANADA: Naugatuck Chemicals, Elmira, Ontario
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N. Y.

Bright good looks that **WON'T** *wear off ... value that* **CAN'T** *wear out!*



WRITE TODAY

For These Publications

1. SPECIAL STEELS FOR INDUSTRY . . . 16 pages of essential data on the proper selection and application of principal AL special alloy products: stainless, tool and electrical steels and sintered carbides.

2. PUBLICATION LIST . . . a complete listing of all AL publications, both technical and non-technical (over 100 in all), with a handy order form for your convenience.

ADDRESS DEPT. SA-65

Stainless steel brightwork (ask about it on the car *you* buy!) has much more than surface attractiveness. It has built-in, *timeless* beauty. Beauty that goes all the way through—doesn't scratch off or rust off. Beauty that lasts—outlives the car itself. And beauty that's practical . . . requires no weary polishing, just ordinary washing.

In fact, *wherever* it's used, Allegheny Metal delivers something extra in good looks, strength, service life and resistance to rust and wear. Even where its first cost is higher (and that's not always the case) stainless steel usually costs much less in the end, because it lasts so much longer than other materials.

Allegheny Metal has given thousands of products a competitive edge: all sorts of products, from safety pins to railroad trains. Maybe there's a place in *your* business where it can boost sales appeal or reduce costs. Let's help you look. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

Make it BETTER-and LONGER LASTING-with

Allegheny Metal®

WAD 4933 C

AL TIME-TESTED STAINLESS STEEL

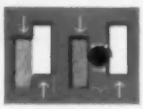
Warehouse stocks carried by all Ryerson steel plants

HERE'S A BETTER ACTUATION METHOD!

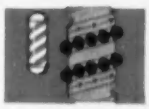
Saginaw ball/bearing Screws can help you solve weight, power and temperature problems

EXCLUSIVE FAIL-SAFE MULTIPLE CIRCUITS
If one circuit should fail, the rest will function without interruption, sharing the load between them. In critical applications this exclusive feature has no equal.

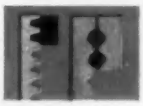
WHAT IT IS AND HOW IT WORKS



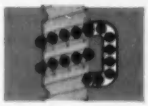
Let's start at the beginning, with the familiar principle that there's far less friction in *rolling* than in *sliding*. By applying this principle,



Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.



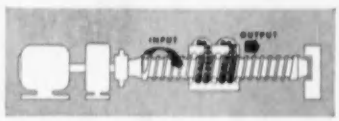
the *Safety ball/bearing Screw* radically increases the efficiency of rotary-to-linear motion (and vice versa). Instead of *sliding*, mating surfaces *glide* on rolling steel balls.



At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate.

TREMENDOUS ADVANTAGES IN AIRCRAFT ACTUATION

Conventional Acme screw's efficiency is less than 25%; *Safety ball/bearing Screw's* ranges from 90 to 95%! Combined with electric, hydraulic or pneumatic power source, it forms an actuator for aircraft (and similar uses) that:



SAVES WEIGHT—permits use of smaller motors and gear boxes; eliminates pumps, accumulators, piping, etc.

SAVES POWER—Safety b/b Screw requires only 1/3 as much torque for same lineal output as conventional Acme screw.

SOLVES TEMPERATURE PROBLEMS—operates successfully from −75°F to +900°F —and *without lubrication*, if needed.

ASSURES POSITIVE POSITIONING—permits precision control within thousandths of an inch, plus perfect synchronization.

INCREASES DEPENDABILITY—offers longer life and added security of *exclusive multiple circuits*, plus greatly decreased dirt sensitivity of special "Gothic arch"-shaped races.

REDUCES PART AND INSTALLATION COSTS—savings in weight, motor size, power and auxiliary equipment cut cost, too.

ANY SIZE FROM 1½ INCHES TO 39½ FEET IN LENGTH

Every *Safety b/b Screw* is individually engineered for its particular application. Our engineers are eager to help solve your actuator problems *now*.

MAIL COUPON TODAY FOR YOUR ENGINEERING DATA BOOK

(or see our section in Sweet's Product Design File)

Saginaw Steering Gear Div.
General Motors Corp.
Dept. 2E, Saginaw, Michigan

Please send your Engineering Data Book to:

Name—Title.....

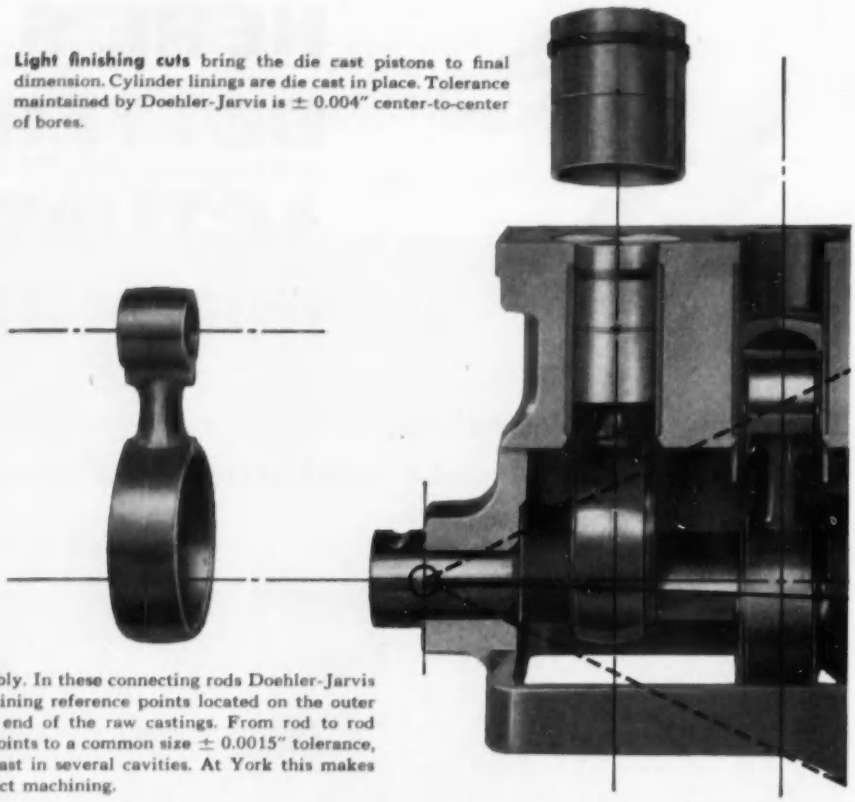
Firm.....

Address.....

City.....Zone.....State.....

Safety ball/bearing Screw by Saginaw

Light finishing cuts bring the die cast pistons to final dimension. Cylinder linings are die cast in place. Tolerance maintained by Doehler-Jarvis is ± 0.004" center-to-center of bores.



Cast-in chamfers aid assembly. In these connecting rods Doehler-Jarvis dies also establish two machining reference points located on the outer circumference of the throw end of the raw castings. From rod to rod Doehler-Jarvis holds these points to a common size ± 0.0015" tolerance, even though they must be cast in several cavities. At York this makes for smooth, precise, low-reject machining.

How Doehler-Jarvis helped make hermetic compressors lighter and

This is a story of practical product engineering.

Its concern is with things you may want for your product. Reduced size, weight, cost. Stepped up efficiency. Increased life. These were what York Corporation wanted for its post-war "packaged" air conditioners.

And at war's end, York was ready with a revolutionary, new hermetic compressor design. Small, simple, efficient. Aluminum for lightness. Now . . . how should it be made?

Cool! Light, small die cast compressors make York Window Conditioners compact, efficient and good for years of trouble-free service.

Three cost factors favor die casting

1. Raw castings cost less (less metal to buy)
2. Less machining was needed (less waste, fewer man-hours)
3. Tooling requirements were lower (fewer tools, lighter and less costly)

With these factors in mind, York took their two-cylinder, ¾ H.P. compressor* as a starter and went into production. Within a few years their whole line was converted to the new die cast design. Later . . .

York sees a way to cut size and weight even more

Doehler-Jarvis was asked to incorporate compressor and motor housing into a one-piece die cast unit. A series of conferences followed.

Together, engineers from both companies solved one problem after another. Precise dimensional control. Cast-in-place cylinder linings. Die cast bearing surfaces. Concentricity and precise location of cylinder center lines. (To solve this one, Doehler-Jarvis had to provide in the

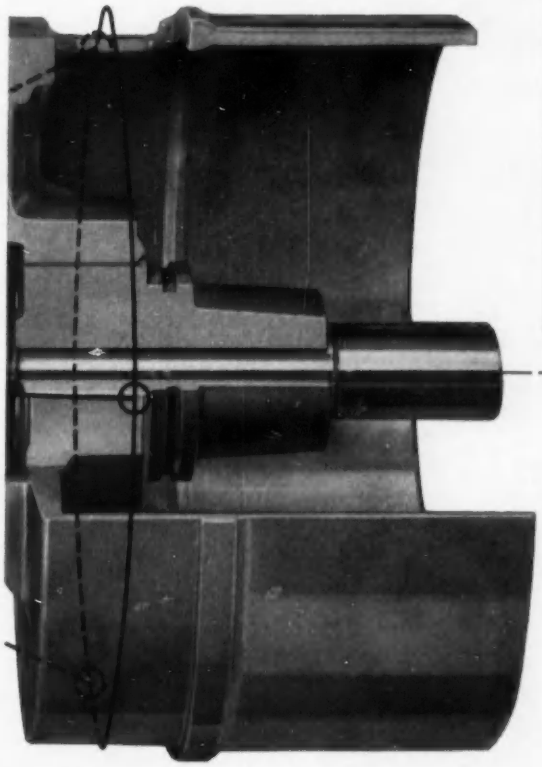
*Test units, run continuously ever since, have logged over 70,000 hours without failure.

"Phantom" control cone, with three "no tolerance" chucking surfaces, establishes precision

In the raw casting three equidistant chucking surfaces are established by the Doehler-Jarvis die. Their centers are located on a circle concentric with and exactly perpendicular to the shaft. The plane thus established forms the base of a "phantom" control cone (see illustration) whose apex is at the small bearing bore.

From this cone as a reference, all center lines and true surfaces throughout the piece are established. All machining setups, too, are based upon it.

At the Doehler-Jarvis plant, great care is taken to hold the chucking surfaces true. Aside from very slight variations in cooling, no tolerance is allowed. As a result, York machining proceeds smoothly with minimum rejects at every stage. What's more, the resulting precision insures long wearing bearings, long life pistons and cylinders.



more compact through die casting

die for three "no-tolerance" chucking surfaces on the raw casting . . . precisely located with respect to the front bearing bore.)

This expert product engineering team went on to develop for other sizes other integrated die cast housings, and the connecting rods, pistons, main bearings, and oil slinger rings. These compressors are light, compact and highly efficient. They can be produced quickly and easily.

"Cannot be matched for low cost," York says

"What's more, because the parts can be die cast in a hurry . . . and because Doehler-Jarvis never fails us on delivery . . . we stay flexible. We're able to meet peak demands for air conditioners without going overboard on finished inventory."

Come back to the things you want to do for your own product . . . maybe Doehler-Jarvis could help you do them with die castings. We've done it for scores of manufacturers, large and small—including makers of home appliances, office and public utilities equipment, industrial machines, and many other similar products made better with die castings.

So, if you are engineering a new product or improving the one you have, call in Doehler-Jarvis. With more than fifty years experience behind us, we may be able to contribute in many ways.

Doehler-Jarvis Division

of

National Lead Company

General Offices: Toledo 1, Ohio

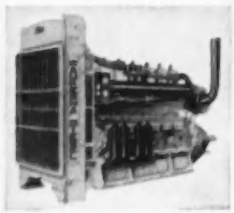
WAUKESHA

ENGINES and POWER UNITS—10 hp.-1135 hp.

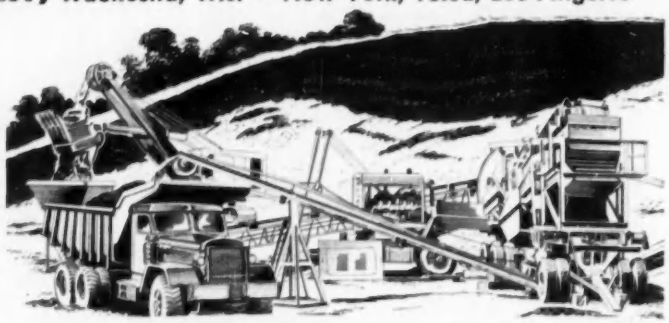
Normal and Turbocharged Diesels, Gasoline, Natural Gas, LPG ···
Standard or Counterbalanced Crankshafts

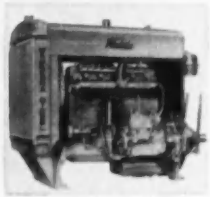
WAUKESHA MOTOR COMPANY, Waukesha, Wis. • New York, Tulsa, Los Angeles

Model VLRDBS

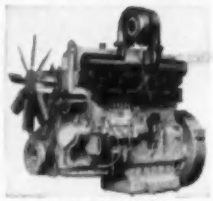


Model LRDBS





Model 148-DK



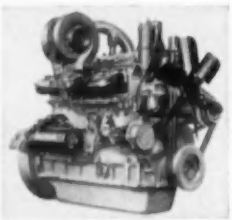
Model WAKDBS

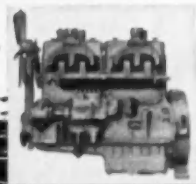
Displ. Cu. In.	Bore and Stroke	Standard Crankshaft		Counterbalanced Shaft		Features*
		Model	HP @ RPM	Model	HP @ RPM	
NORMAL DIESEL ENGINES						
144	3½x3¾	.....	.....	180-DLC	45 @ 2400	4AOW
216	3½x3¾	185-DLC	60 @ 2400	.....	.....	6AOW
265	3¾x4	190-DLC	84 @ 2400	190-DLCA	85 @ 2800	6AOW
302	4 x4	195-DLC	96 @ 2400	195-DLCA	98 @ 2800	6ADO
426	4¼x5	135-DK	140 @ 2400	135-DKB	147 @ 2800	6ADO
779	5¼x6	148-DK	169 @ 1600	148-DKB	200 @ 2100	6AOW
1197	6¼x6½	WAKD	220 @ 1500	WAKDB	258 @ 1800	6AOW
1905	7 x8¼	.....	.....	NKDB	297 @ 1200	6AOW
2894	8½x8½	.....	.....	LRDB	415 @ 1200	6AOW
5788	8½x8½	.....	.....	VLRDB	830 @ 1200	12AOW
TURBOCHARGED DIESEL ENGINES						
426	4¼x5	.....	.....	135-DKBS	185 @ 2800	6ADO
779	5¼x6	.....	.....	148-DKBS	280 @ 2100	6AOW
1197	6¼x6½	.....	.....	WAKDBS	352 @ 1800	6AOW
1905	7 x8¼	.....	.....	NKDBS	390 @ 1200	6AOW
2894	8½x8½	.....	.....	LRDBS	570 @ 1200	6AOW
5788	8½x8½	.....	.....	VLRDBS	1135 @ 1200	12AOW
GASOLINE, GAS ENGINES						
61	2½x3⅛	ICK	18 @ 3200	.....	.....	4ILN
133	3¼x4	FC	34 @ 2600	.....	.....	4ILN
144	3½x3¾	.....	.....	180-GLB	45 @ 2400	4AOW
186	3⅜x4½	XAH	47 @ 2200	.....	.....	4ILN
216	3½x3¾	185-GLB	67 @ 2400	.....	.....	6AOW
265	3¾x4	190-GLB	77 @ 2400	.....	.....	6IOW
302	4 x4	195-GL	85 @ 2400	.....	.....	6DIO
320	4⅛x4	195-GK	103 @ 2400 (I)	195-GKA	122 @ 3000 (F)	6ANO
404	4¼x4¾	MZA**	128 @ 2800 (F)	.....	.....	6ALN
426	4¼x5	135-GK	134 @ 2400	135-GKB	147 @ 2800 (F)	6ADO
451	4⅜x5	135-GZ	143 @ 2400	135-GZB	153 @ 2800 (F)	6ANO
525	4½x5½	140-GK**	160 @ 2250 (F)	140-GKB	177 @ 2600 (F)	6AOW
554	4⅜x5½	140-GZ	168 @ 2250 (F)	140-GZB	188 @ 2600 (F)	6AOW
779	5¼x6	145-GK**	216 @ 2000 (F)	145-GKB	240 @ 2400 (F)	6AOW
817	5⅜x6	.....	.....	145-GZB	250 @ 2400 (F)	6AOW
1197	6¼x6½	WAK	222 @ 1600	WAKB (A)	280 @ 1800	6IOW
GAS ENGINES						
1197	6¼x6½	WAKR	290 @ 1800	WAKB	300 @ 1800	6AOW
1905	7 x8¼	.....	.....	NKRB	325 @ 1200	6AOW
2894	8½x8½	.....	.....	LRORB	465 @ 1200	6AOW
3520	9⅜x8½	.....	.....	LRZB	594 @ 1200	6AOW
5788	8½x8½	.....	.....	VLROB	900 @ 1200	12AOW

* **Features:** 4, 6, 12-Number Cylinders, A-Aluminum Pistons, D-Dry Sleeves, I-Iron Pistons, L-L-head, N-No Sleeves, O-Overhead Valves, W-Wet Sleeves.

** Also, with iron pistons for low speed service. (F)-Rated higher for fire service.

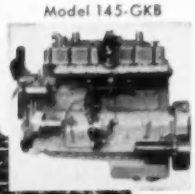
Model 135-DKBS

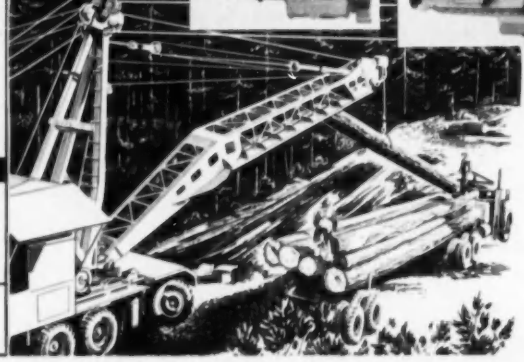




Model WAKD

Model 145-GKB



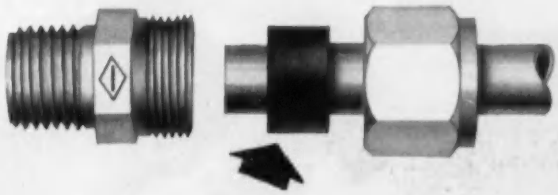


278

The Fitting that Never Gets Tired of Absorbing Shocks and Vibration!

IMPERIAL FLEX FITTINGS

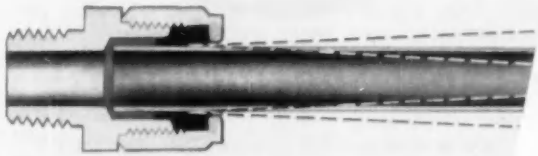
. . . Make Tube Fitting Failures Unnecessary



Every Flex Fitting embodies this vibration and shock absorbing sleeve.

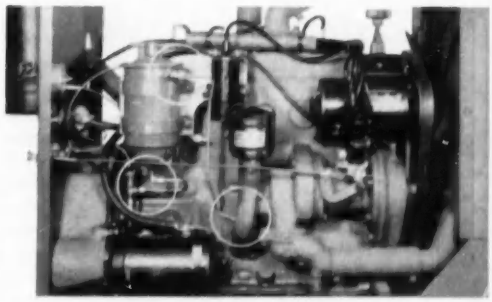
FLEX FITTINGS make safer joints that are virtually indestructible by vibration . . . absorb shock and minor tube movement . . . assure a positive pressure-tight seal.

FLEX FITTINGS are very easy to install . . . simply slip nut and Flex sleeve over tubing . . . insert tubing into body and tighten nut — that's all!



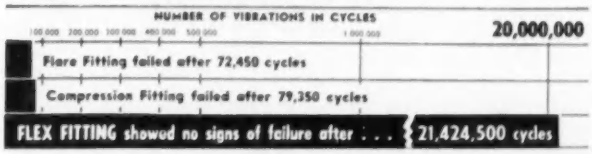
The Flex Fitting actually permits the tube to flex back and forth through angle shown. Note that tubing is cushioned against any damage.

FLEX FITTINGS can be used with all kinds of tubing



If you have a tough tubing connection job that involves vibration, shock or tube movement, it will pay you to consider IMPERIAL FLEX FITTINGS. Whether it's tractors, diesels, heavy power equipment, machinery or earth movers, you will be safe with FLEX FITTINGS. Thoroughly proved by extensive use.

Comparative Vibration Test Results


NUMBER OF VIBRATIONS IN CYCLES
20,000,000
Flare Fitting failed after 72,450 cycles
Compression Fitting failed after 79,350 cycles
FLEX FITTING showed no signs of failure after . . .
21,424,500 cycles

On vibration tests, where other fittings failed quickly, Flex Fittings withstood over 20,000,000 cycles without sign of failure.

Ask for Catalog 344

THE IMPERIAL BRASS MANUFACTURING COMPANY

1225 W. Harrison St., Chicago 7, Ill.

In Canada: 334 Lauder Ave., Toronto, Ontario

IMPERIAL

Pioneers in Tube Fittings and Tube Working Tools

...and Always to Your Exact Specifications!

Western Felts are highly versatile! That's **one of their tremendous advantages** wherever you can use a felt component to help the performance of your product. We start with the very picking and carding of the millions of tiny wool fibres, with every process in our plant under our complete control!

Western Felts are made soft and springy, dense and hard, or of any of the unlimited degrees of density in between. They are conditioned for the exact jobs they are to perform, right down to the precision cutting to extremely close tolerances. Especially in the more dense consistencies, tolerances often are as close as a few-thousandths of an inch!

Wear, age and weather do not affect Western Felt parts. They deaden sound, seal against dust, greases and oils, or they are made to absorb and feed oil when used for lubrication...*exactly* as you wish. Western Felt parts can be chemically treated for hardness, waterproofing, mothproofing, oil retention, abrasion resistance...or greater tensile strength.

Western Felt components will help solve many of your problems. You are invited to consult with our engineers.

WESTERN Felt WORKS

4021-4239 W. Ogden Ave., Chicago 23, Illinois
Branch Offices in Principal Cities

MANUFACTURERS AND CUTTERS OF WOOL FELT

EXTRA Mobile Equipment News EXTR
VOL. 2 VICKERS INCORPORATED, DETROIT, MICHIGAN NO. 6

NEW—For Smaller Vehicles

VICKERS HYDRAULIC POWER STEERING

LOW COST
Vickers Series S22 is a new, streamlined steering booster built especially for smaller vehicles. The design permits high production economies . . . and these economies are passed on to vehicle manufacturers.

SUPERIOR PERFORMANCE
The Series S22 has excellent operating characteristics . . . providing smooth, easy, fingertouch steering under all conditions. Obstructions, chuck holes, blown tires, etc. cannot spin the steering wheel or jerk it out of control on vehicles equipped with this Booster. Safer in traffic . . . on the farm . . . in the plant.

SIMPLIFIED DESIGN
Servo valve is simplified and smaller. Ease of servicing is another advantage.

EASY INSTALLATION
Oil connections can be placed in any one of four positions (90° apart) with respect to ball stud. This and the compact design make installation exceptionally easy and reduce its cost.

NEEDS LESS SPACE
Design is unusually compact and streamlined. Series S22 will go into a minimum space and usually requires little or no linkage change.

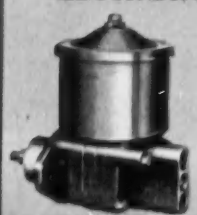
DEPENDABLE
All the "know-how" acquired in Vickers more than 25 years experience with hydraulic power steering has gone into the design and manufacture of the Series S22. Vickers hydraulic equipment of all kinds has a remarkable record of dependability. This booster is no exception.

ASK FOR NEW BULLETIN
A new bulletin gives more information on the Series S22 together with appropriate Vickers Pumps and typical circuit diagrams. Send for Bulletin M-5107.

For heavier steering applications and longer piston strokes, use Vickers Booster Series S23 (see Bulletin M-5106) or Model S6-315 (see Catalog No. M-5101).

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1440 OAKMAN BLVD. • DETROIT 32, MICH.
Application Engineering Offices: ATLANTA • CHICAGO AREA (Brookfield) CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS • NEW YORK AREA (Summit, N.J.) PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) SEATTLE • ST. LOUIS • TULSA • WASHINGTON • WORCESTER

VICKERS SERIES VT16 VANE TYPE PUMP



This is the pump normally used with the Series S22 Booster. It has integral volume control and relief valve, and oil reservoir. The vane type design delivers more oil with less power. Automatic wear compensation and hydraulic balance contribute to much longer life with minimum maintenance. No-load starting is another advantage in cold weather.

7179

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

THE NEW Spicer
– already adopted by 3 of

Lessens Driving Fatigue!

Dampens Vibration!

Lengthens Truck and Parts Life!

Deadens Noise!

Saves Drivers!

Detail View of New
Spicer Center Bearing Mounting

Patent Pending

Reduces Hum!

Saves Repairs!

Spicer

DANA CORPORATION

CENTER BEARING MOUNTING

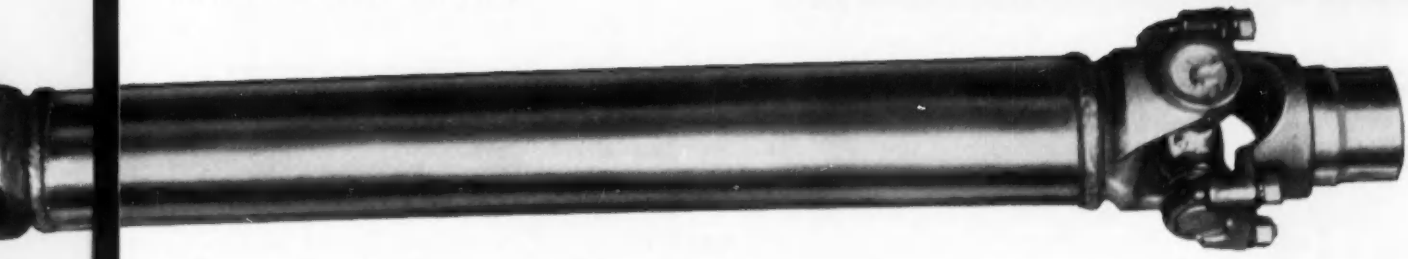
the top 5 Truck Producers!

In the merciless testing of new developments for the automotive industry, the new Spicer Center Bearing Mounting has emerged with outstanding records of performance

. . . and quick acceptance as standard equipment on leading makes of trucks!

This new Spicer mounting for propeller shafts is an exceptional engineering advancement. It embodies a revolutionary combination of ball bearing and low-frequency rubber. This achieves remarkably low vibration transmissibility at driving speeds. It dampens . . . deadens . . . absorbs nearly all the vibration disturbances transmitted to it from the drive line.

The Spicer Center Bearing Mounting is available for original truck equipment, as an integral part of the Spicer Propeller Shaft assembly. It is another Spicer engineering "first," typical of Spicer pioneering that has been dedicated to the advancement of the automotive industry.



TOLEDO 1, OHIO

SPICER PRODUCTS: TRANSMISSIONS • UNIVERSAL JOINTS • PROPELLER SHAFTS • AXLES • TORQUE CONVERTERS • GEAR BOXES • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES • STAMPINGS • SPICER and AUBURN CLUTCHES • PARISH FRAMES

Two views of Heald-Boramatic boring machines equipped with U. S. PowerGrip TIMING Belts and sheaves. Note the teeth in the belts and in the pulleys. They transmit the power of 2 motors on each machine, and are subjected to tremendous shock loads.

A leading auto plant reaps savings in production time and labor... by installing U. S. *PowerGrip* "TIMING"® Belts

By changing its power transmission (on Heald-Boramatic machines) to U.S. PowerGrip TIMING Belts, the auto plant gained these immediate mechanical benefits:

- Sheaves and belts were reduced in number on each machine from 6 to 4.
- Previous belts had to be replaced every 2 weeks. U.S. PowerGrip TIMING Belts have been on the job for 3 months—yet show *no sign of wear!*
- The machines are now far more efficient. They deliver a more uniform speed and, because they do not stall, they give a better finish to the work.

So convincing was the saving in production time and the reduction in maintenance and replacement of parts, that the management of the auto plant has now equipped all Heald-Boramatics with U.S. PowerGrip TIMING Belts and sheaves.

A development of United States Rubber Company, the U.S. PowerGrip TIMING Belt has grooves which fit into teeth in the pulleys—with perfect non-slip grip and a uniform transmission of power. This belt has revolutionized power transmission in hand tools, lathes, drill presses, saws, electric typewriters and thousands of other applications. The absence of metal-to-metal contact makes lubricants and oil-retaining housings unnecessary. The smaller pulleys permit very short centers and high ratios. Light weight permits very high speeds, yet with its non-slip grip the belt can handle speeds so slow as to be almost imperceptible to the eye. Because there are no friction-creating joints, no slippage, no lubricated drag, the U.S. PowerGrip belt has an efficiency close to 100%. Obtainable at any of our selected distributors or 27 "U.S." District Sales Offices or write address below for free catalog.

"U.S." Research perfects it . . ." U.S." Production builds it . . . U.S. Industry depends on it.

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

The Most Trusted Name in Ignition

Pioneers in Development of Vibration-Resistant Electrical Connector

The unsatisfied demand for a rugged, dependable connector capable of meeting the exacting requirements of modern aircraft led the Scintilla Division of Bendix* to develop the *first* vibration-resistant electrical connector. These connectors using the revolutionary new insert material known as Scinflex were first used on Scintilla Division's ignition equipment for piston engines.

So outstanding was the performance of this new and better connector that its acceptance and use have now become world-wide. Today the Scintilla Division is a major contributor to the electrical connector industry.

This pioneering has never stopped. Bendix was first in the field with cadmium plated connectors, which were later made a requirement of military specifications. Our latest contribution is the best engineered closed entry socket contact available anywhere—one which cannot be mechanically overstressed.

*TRADE-MARK.

SCINTILLA DIVISION
of Bendix
AVIATION CORPORATION
SIDNEY, NEW YORK

AVIATION PRODUCTS: Low and high tension ignition systems for piston, jet, turbo-jet engines and rocket motors . . . ignition analyzers . . . radio shielding harness and noise filters . . . switches . . . booster coils . . . electrical connectors.

Export Sales: Bendix International Division • 205 East 42nd St., New York 17, N. Y.

FACTORY BRANCH OFFICES: 117 E. Providencia Ave., Burbank, Calif. • Stephenson Bldg., 6560 Cass Ave., Detroit 2, Mich. • 512 West Ave., Jenkintown, Pa. • Brouwer Bldg., 176 W. Wisconsin Ave., Milwaukee, Wisc. • American Bldg., 4 South Main St., Dayton 2, Ohio • 8401 Cedar Springs Rd., Dallas 19, Texas

Bendix

Looking for better parts at lower costs?

B-N BRAZED ASSEMBLIES MAY BE YOUR ANSWER

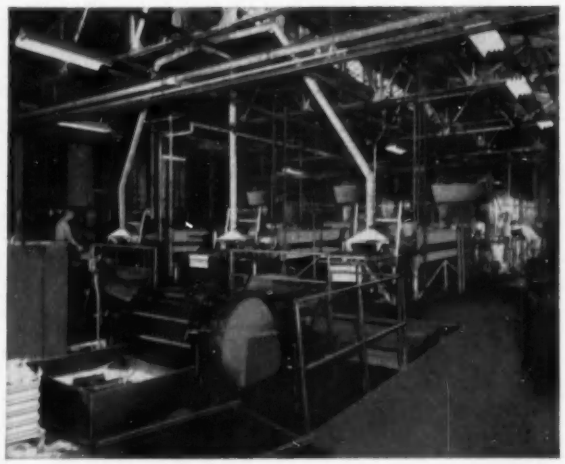
Burgess-Norton, one of the pioneers in production hydrogen-copper brazing, today serves industry with over $1,000,000 worth of diversified brazing equipment... utilized for an ever-widening range of components.

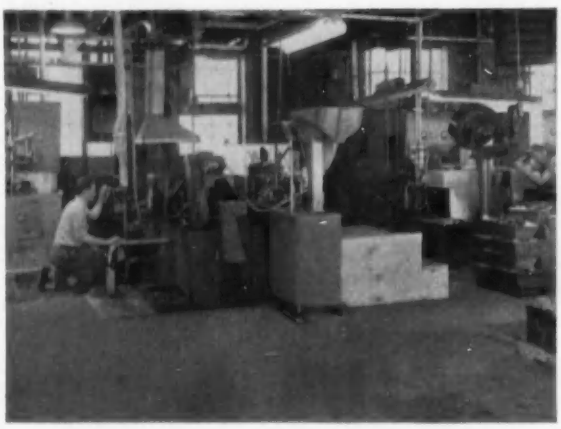
Over the past few years an increasing list of customers have found that redesigning their parts for production as brazed assemblies has made possible a new high in quality and performance, at reduced costs.

Quality is improved for many reasons... greater control of production and materials, closer tolerances, specialized steels in each part of the unit for specific requirements, more accurate heat treating results, greater uniformity throughout.

Costs are reduced, too, for varying reasons... sometimes because of the increased production possible by combining stampings and machined parts through brazing... or because material is saved because of the efficiency of brazed production... perhaps the savings are because the utilization of B-N facilities obviated installation of costly equipment, or because Burgess-Norton, one of the pioneers in production hydrogen-copper brazing, has gained valuable experience and knowledge that saves the customer through the total of many small efficiencies.

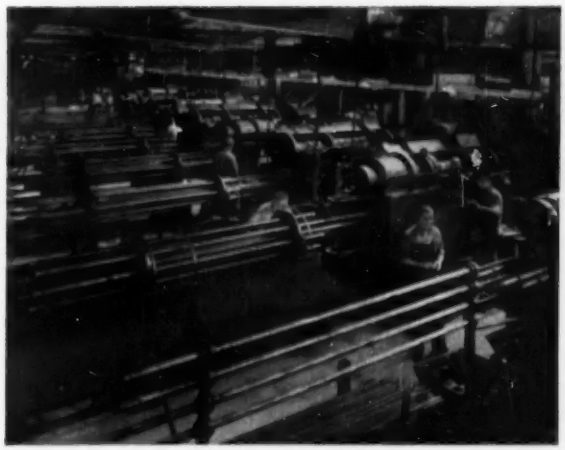
Brazed assemblies are not the answer to every parts problem, certainly, but they are being employed with advantage in more and more instances. If component parts are required in your production picture, we sincerely believe it will pay you to check with Burgess-Norton. Your inquiry will be handled promptly. If you prefer, a sales representative will call at your convenience.





The exceptional B-N heat treating facilities include both batch type and continuous fed atmosphere controlled furnaces, as well as induction heating. Burgess-Norton was one of the earliest firms to employ large scale induction heating for the treatment of metal.

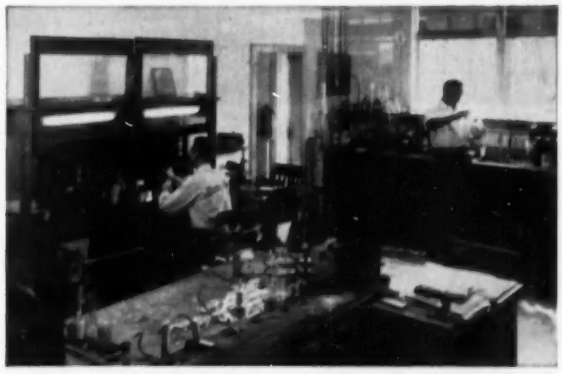
Production of many of the brazed assemblies begins in the stamping department. By combining stampings and machined parts through hydrogen-copper brazing, B-N effects considerable savings in production and at the same time improves performance of the part.



This partial view of the Burgess-Norton screw machine department shows only a few of the basic machines employed in parts production. Facilities include machine tools for all secondary operations, plus a complete tool room.

These assemblies are representative of the many different parts problems that are being solved for industry by B-N engineering, production facilities and experience.

Firm in the knowledge that good parts begin long before actual production, Burgess-Norton maintains a large staff of engineers and an unusually complete metallurgical laboratory. These engineers, experienced in parts redesign for modern production methods, have been a major factor in the B-N "better parts at lower costs" story.



For a more complete picture of Burgess-Norton

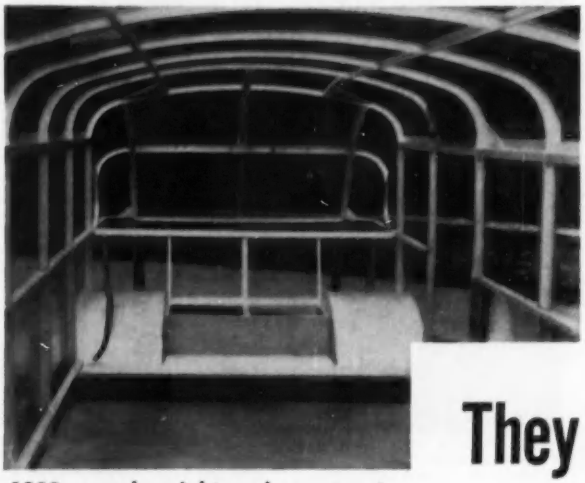
Send today for this FREE facilities brochure

BURGESS-NORTON MFG. CO.

ESTABLISHED 1903

GENEVA, ILLINOIS

SERVING INDUSTRY FOR OVER FIFTY YEARS

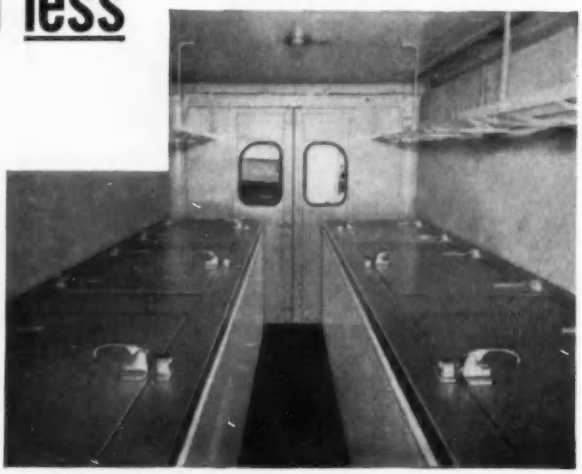


1300-pound weight saving means less wear on tires and brakes, less fuel and maintenance for this 25-passenger type bus body made by Boyertown Auto Body Works, Boyertown, Pa.

Resistant to corrosion, abrasion and impact, nickel alloy steels extend life of 17 basic bodies and more than 100 custom variations put out by Boyertown Auto Body Works.

They Haul more...yet weigh less

50% greater yield strength in sections of ¾" or less, and up to 40% more ultimate strength permit Boyertown to trim about 500 pounds from this type of parcel delivery truck, as compared with carbon steel.



The interior of Boyertown's food-handling trucks is lined with stainless chromium-nickel steel for its corrosion-resistance which assures sanitation.

You, too, can trim needless weight from truck bodies, while adding strength, toughness and corrosion-resistance

Use of high strength, low alloy steels containing nickel is the answer

You can lower haulage costs by designing to utilize high strength, low alloy steels containing nickel.

Several leading steel companies offer these steels. Look for such trade names as Tri-Ten, Cor-Ten, Mayari R, Yoloy, Hi-Steel, Double-Strength, and Dynalloy.

Get all the facts shown in "Nickel-Copper High Strength, Low-Alloy Steels . . ." a manual that is yours for the asking.

It discusses design factors that help you cut weight without sacrificing safety. It explains why these nickel alloy steels provide superior resistance to atmospheric and many other types of corrosion. It describes their behavior in fabrication, as well as applications that illustrate how they may help *you* improve products or equipment.

Take full advantage of the properties these nickel alloy steels offer . . . write for your copy of "Nickel-Copper High Strength, Low-Alloy Steels" now.

INCO
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

New!

ROLLWAY

Sealed Cartridge Bearing

Versatile, low in cost, self-contained, easy to install

The Rollway Sealed Cartridge Bearing is adaptable to a remarkable variety of uses.

Low cost for a wide range of applications is offered by the various seal or retaining disc combinations: 1. A seal at each end; 2. A retaining disc at each end; 3. A seal on one end, retaining disc on the other.

Specifically tailored to each application, the Rollway Sealed Cartridge Bearing prevents dangerous overloading or wasteful underloading (see description of hardening and grinding factors for rollers, at right.) The sealed design keeps dirt *out* and lubrication *in*.

Because it is self-contained, installation is easier, faster, less costly.

FREE ENGINEERING AND METALLURGICAL SERVICE

Let's examine your bearing problems together to see how the new Rollway Cartridge Bearing can cut the costs and improve the performance of your products . . . no cost, no obligation!

RETAINING DISC is available on either or both ends.

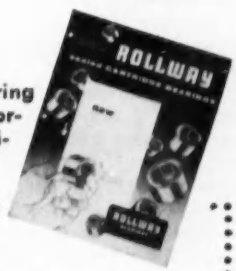
ROLLERS are available in three types: 1. Hardened but unground; 2. Hardened and ground; 3. Unhardened and unground.

SLEEVE is unhardened or heat treated, depending upon use of unhardened or hardened roller assembly.

SEALS are of sintered iron — cannot score shaft. Available on either or both ends.

FREE—
Send coupon below

for Sealed Cartridge Bearing folder, with complete information, sizes, and specifications.



ROLLWAY
BEARINGS
COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

ROLLWAY BEARING CO., INC.
541 Seymour St., Syracuse, N. Y.

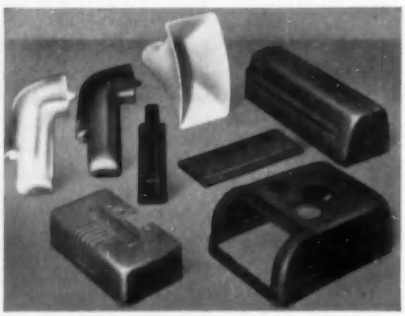
Please send folder of complete information on the new ROLLWAY Sealed Cartridge Bearing.

Name..... Title.....
Firm Name.....
Address.....
City..... Zone.... State.....

ENGINEERING OFFICES: Syracuse • Boston • Chicago • Detroit • Toronto • Pittsburgh • Cleveland • Milwaukee • Seattle • Houston • Philadelphia • Los Angeles • San Francisco

BOB MORRISON and Hal Lathrop, company executive, inspect a truck spare-tire carrier, one of many parts made with HETRON resins at Molded Fiber Glass Body Co., Ashtabula, Ohio.

ALL MOLDED FIBER GLASS PARTS for this pickup are molded by the Body Co., and all use HETRON resin. These parts combine high reverse impact with excellent flexural strength. The ultra-smooth "showroom" surface will take a baked-on alkyd finish without cracking or crazing.



MORRISON CUTS hand-finishing costs as much as 50% by using HETRON on parts like these. HETRON gives a glossy, well-filled surface—beautiful as is, or with a baked-on finish.

"I get the quality moldings I want—with HETRON"

says **Bob Morrison,** *President, Molded Fiber Glass Body Co.*

It's no easy job to meet the requirements of the automotive industry for reinforced polyester body parts.

But Bob Morrison is doing it. Here, in his own words, he tells why he molds with HETRON:

"To make good matched-metal-die moldings of auto body and other large parts, we find it advantageous to use a polyester with the resiliency of a semi-rigid resin, plus the flexural strength of a rigid resin.

"The resin must come through a short cure with practically no surface shrinkage. It must give us an extra-smooth, glossy surface, using the normal resin-to-glass ratio—and with a bare minimum of hand finishing and rejects.

"Then the finished part must take a baked-on alkyd finish at the customer's assembly plant, without a trace of surface crazing.

"It's worth paying a few cents more per pound for resin that gives us results like these in the finished product.

"We get this kind of quality with HETRON resins. Our cost is lower in the long run, because HETRON substantially reduces the amount of hand finishing we have to do."

Bob Morrison gets quality moldings —and so can you—with HETRON.

HETRON resins come to you with permanent, built-in flame resistance. This added bonus can be utilized to its highest degree with the proper choice of fillers.

If you need an assembly, a single part, or a molding material with properties like these, you'll save time by specifying a HETRON resin. HETRON costs a little more. But it gives you results worth a *lot* more.

For a complete technical data file on HETRON resins, and names of fabricators who can supply you, just write us today.

1905—Half a Century of Chemicals
From the Salt of the Earth—1955

HOOKER CHEMICALS

HOOKER ELECTROCHEMICAL COMPANY

38 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y.

NIAGARA FALLS · TACOMA · MONTAGUE, MICH. · NEW YORK · CHICAGO · LOS ANGELES

5-61A

moraine engineering

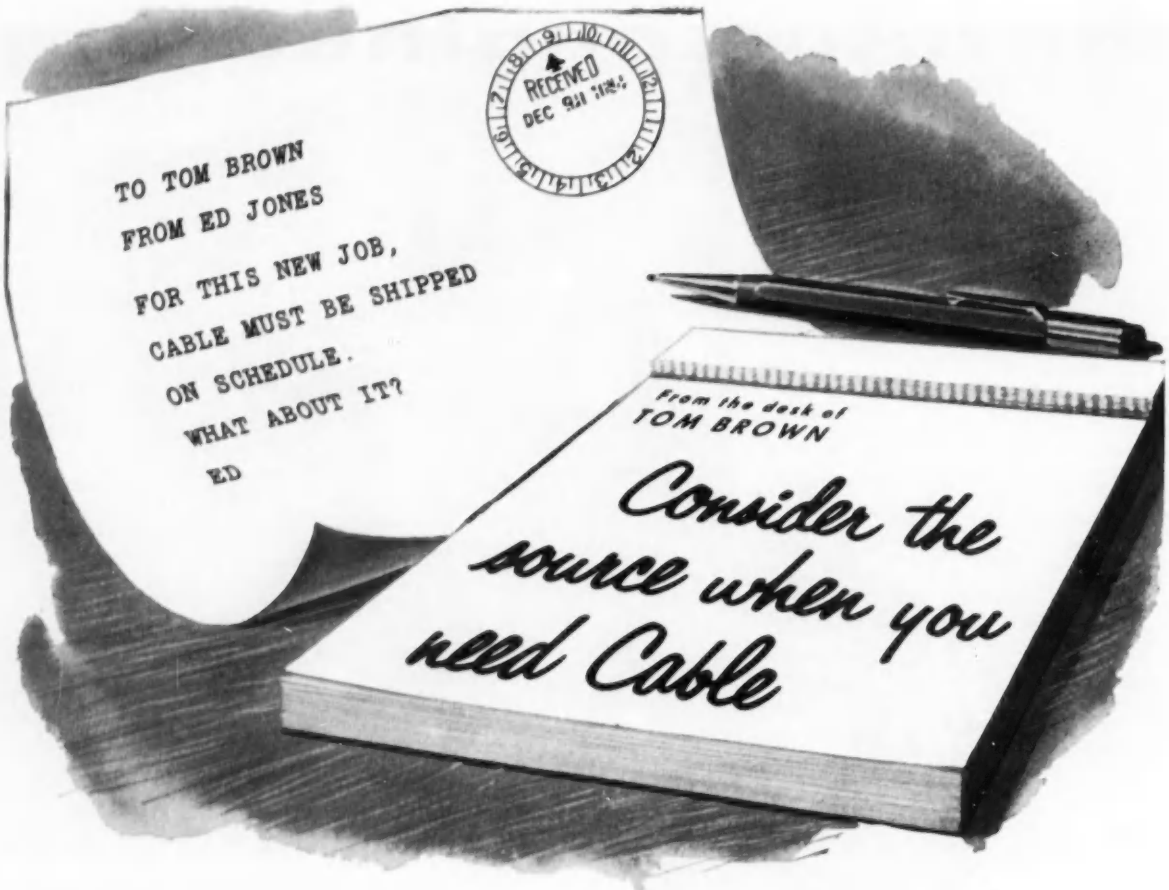
A new and improved spacer for shock absorbers that is now being made in one press operation—with substantial economies for a Moraine customer.

Amazes even engineers!

People sometimes find it hard to believe us when we tell them that parts like these can be made from metal powder in one press operation. Then they're amazed to see us make these and other equally complicated parts easily, economically, in quantity. And when they learn about the over-all advantages — *Improved product performance . . . Lower unit cost . . . Dependable, on-time quantity delivery . . . Engineering assistance . . . Savings in customer investment in equipment and floor space* — they are convinced that Moraine engineering and metal powder techniques may offer real solutions to their own problems.

Moraine products include: Moraine-400 bearings, toughest automotive engine bearings ever made — Moraine friction materials — Moraine metal powder parts — M-100 engine bearings and Moraine conventional engine bearings — Self-lubricating bearings — Moraine porous metal parts — Moraine power brakes — Delco hydraulic brake fluids — Delco master cylinders, wheel cylinders, lined brake shoes and parts.

moraine products
DIVISION OF GENERAL MOTORS, DAYTON, OHIO



Prompt, dependable delivery schedules are important to any manufacturer. And promptness is the natural result of Packard Electric's flexible, carefully regulated production schedules. Add to this the high quality of Packard cable that consistently meets or exceeds applicable specifications, and you have two of the many benefits you can enjoy through dealing with Packard Electric.

Consider Packard as a source

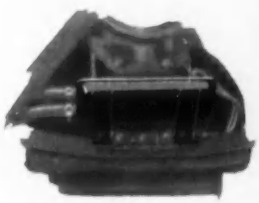
In addition to facilities sufficient to manufacture *daily* more than 7,000,000 feet of cable and more than 800,000 wiring assemblies, Packard Electric can offer you the services of its large engineering staff to help solve any cable problem. These benefits have often meant big savings for Packard customers. It is quite possible that they could be of equal value to you.

GM GENERAL MOTORS Packard REG. U.S. PAT. OFF.

Packard Electric Division, General Motors, Warren, Ohio
Offices in Detroit, Chicago, and Oakland, California

AVIATION, AUTOMOTIVE AND APPLIANCE WIRING

COOL GO FOR BUICK'S DYNAFLOW!



Every Dynaflow transmission ever built has been equipped with a durable, dependable Harrison oil cooler.

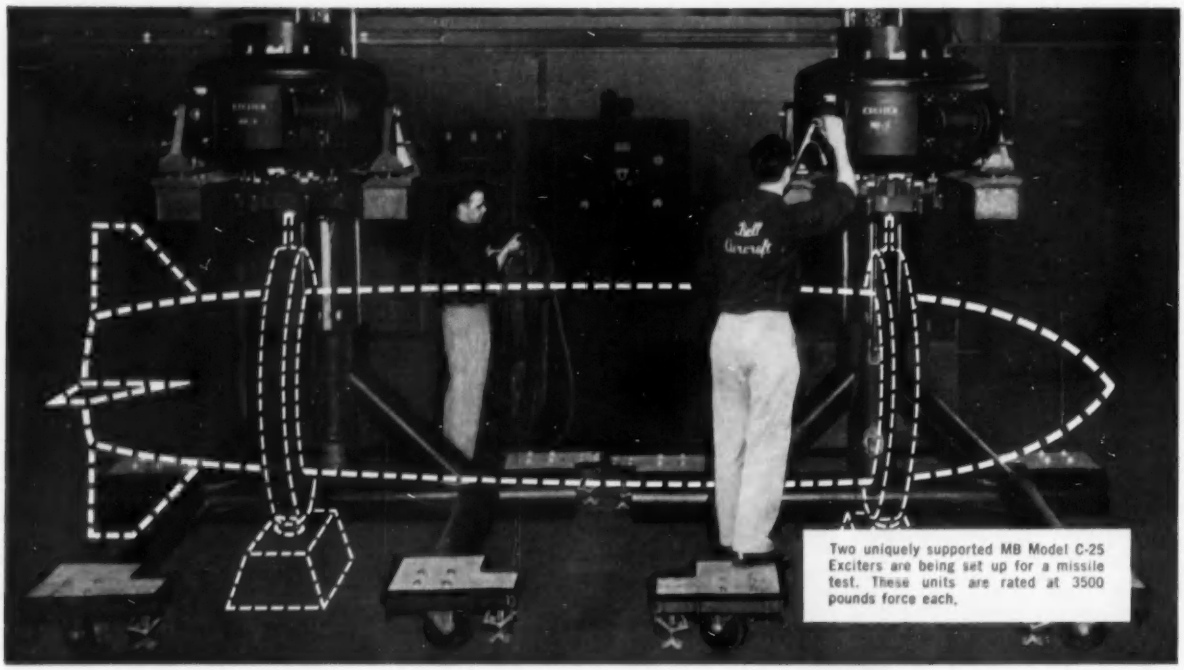
Hot performer . . . but cool as they come! That's Buick's famous Dynaflow transmission! And it's kept cool —at perfect operating temperature—by Harrison! In fact, Harrison oil coolers control temperature on millions of the best-known, most-dependable automatic transmissions on the road today! Harrison heat control products are rugged and reliable . . . designed to save space, weight—money, too! And with our extensive research facilities, we're constantly searching for, and *finding*, better ways to build all kinds of automotive, aircraft, marine and industrial heat transfer equipment! If you have a hot or cold problem, look to Harrison for the answer!

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORP., LOCKPORT, N.Y.

TEMPERATURES MADE TO ORDER

HARRISON

"Shake" tests add extra margin of reliability at BELL *Aircraft*



Two uniquely supported MB Model C-25 Exciters are being set up for a missile test. These units are rated at 3500 pounds force each.

Operation and quality quickly checked on

M B VIBRATION EXCITERS

Engineers of Bell Aircraft Corporation take advantage of the unusual help provided by shake testing – with a specially mounted setup of two MB Model C-25 Exciters for vibrating missiles.

BENEFITS OF SHAKE TESTING

Because small vibrations can be magnified in a complex missile structure, and because interactions of components are important, such testing checks vital systems. The MB shakers permit Bell engineers to produce conditions more severe than expected in service. In effect, a margin of safety can thereby be added to increase reliability of operation.

Moreover, vibration tests afford a quick, versatile means for checking quality of components. Defective and malfunctioning components are quickly detected.

To cap it all, substantial savings in manhours and fuel costs have been effected by substituting shake tests for hot firing of missiles prior to flight tests.

WHY MB VIBRATION EXCITERS?

Engineered by vibration specialists to deliver maximum performance, MB Shakers can be counted on for pure table motion and dependable operation to full rated capacity. MB's line of vibration testing "tools" is complete – from small specialized-duty shakers to the largest in existence today.

Prompt servicing provided by a special staff of MB engineers. For more information on shakers, send for Bulletin 1-VE-7.

the MB manufacturing company, inc.

1060 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO *ISOLATE* VIBRATION...TO *EXCITE* IT...TO *MEASURE* IT

THE WHOLE ROHR STORY
IS IN MILLIONS OF PARTS!

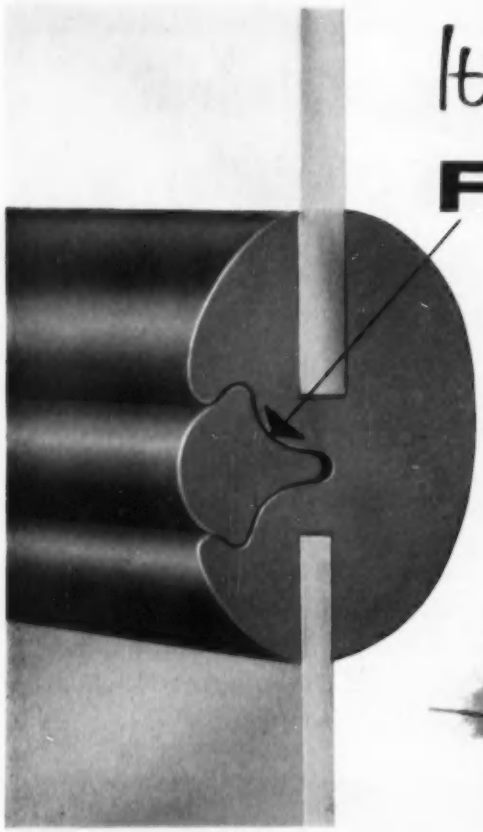
ROHR has won fame for becoming the world's largest producer of ready-to-install power packages for airplanes . . . like the Lockheed Constellation, Douglas DC-7, the all-jet Boeing B-52 and other great military and commercial planes. But there's far more to the ROHR story!

In addition to power packages, ROHR aircraftsmen are currently producing over 30,000 other different parts for aircraft of all kinds.

Whenever you want aircraft parts better, faster, cheaper...call on ROHR. Remember, the whole ROHR story is in the great engineering skill and production know-how gained from building thousands upon thousands of power packages and millions of other aircraft parts.

WORLD'S LARGEST PRODUCER OF READY-TO-INSTALL POWER PACKAGES FOR AIRPLANES
-RECIPROCATING, TURBO-PROP, TURBO-COMPOUND AND JET.

ROHR
AIRCRAFT CORPORATION — CHULA VISTA AND RIVERSIDE CALIFORNIA



It's this separate FILLER STRIP

that puts more pressure on the fence and the glass... providing a permanent leak proof seal!

The filler strip makes possible these other Inland advantages!

If you're having trouble with windows and windshields that only slow up the rain, then you've probably looked longingly at a competitor's model and asked yourself . . . "how do they do it?" At first glance, their seals seem no different from your own . . . and yet—look closely. See that filler strip? That means they're using Inland's new self-sealing weather strip. No wonder they have no leak problems.

The installer compresses the strip *after* the glass is in place. No more forcing the glass into a groove. What's more, Inland weather strip is, by far, the easiest to install!

INLAND MANUFACTURING DIVISION
General Motors Corporation • Dayton, Ohio

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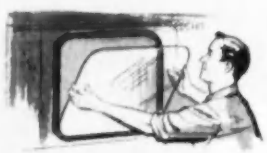

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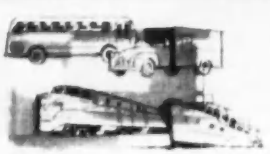

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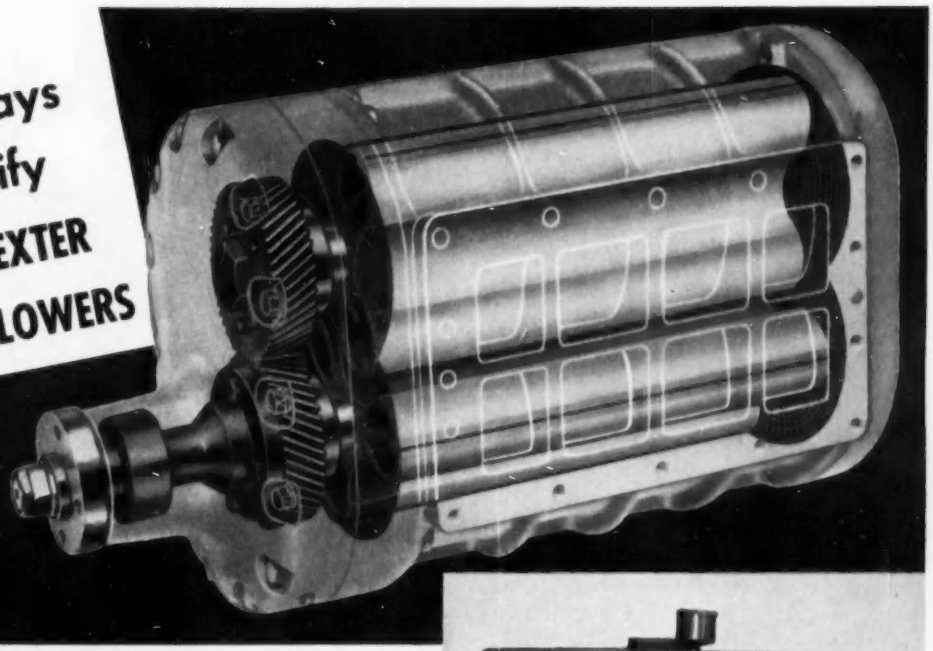

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When Greer Hydraulics, Inc., called in Miehle-Dexter for Blowers on their aircraft cabin leakage test stands, the prime requisite was a lightweight, positive pressure blower to fit in limited space.

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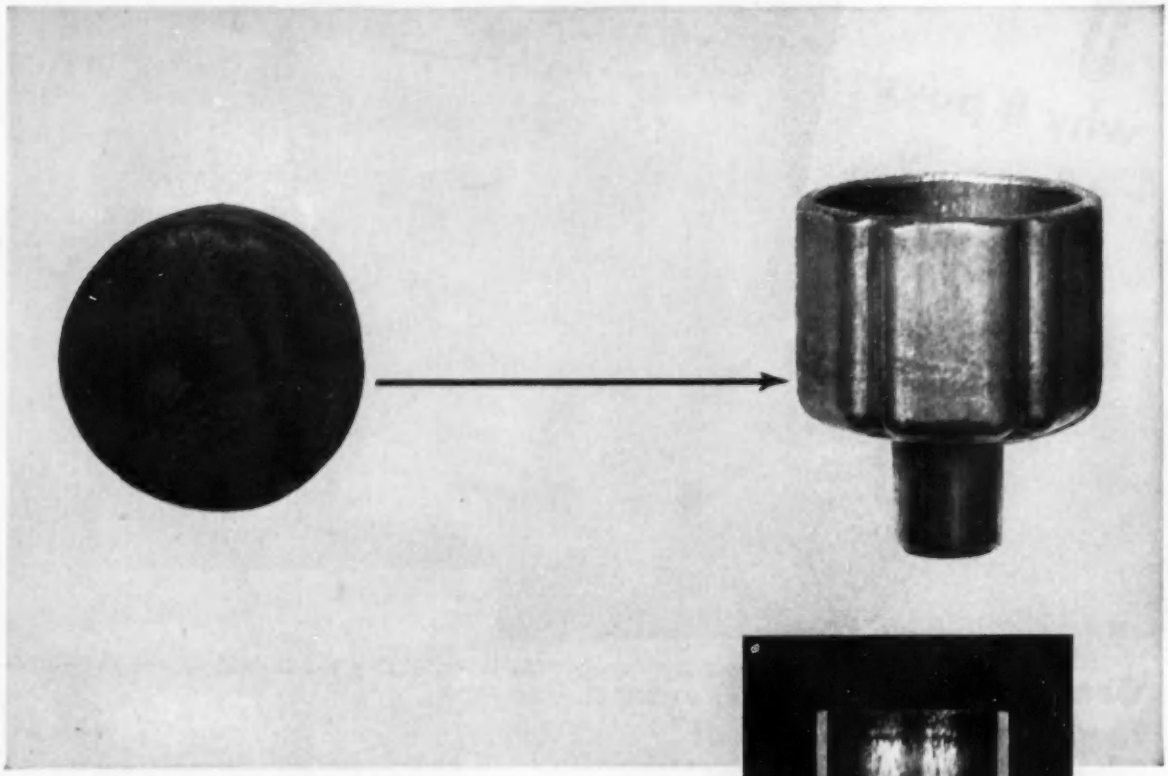

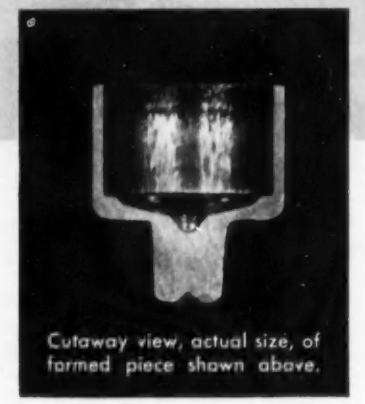

Cutaway view, actual size, of formed piece shown above.

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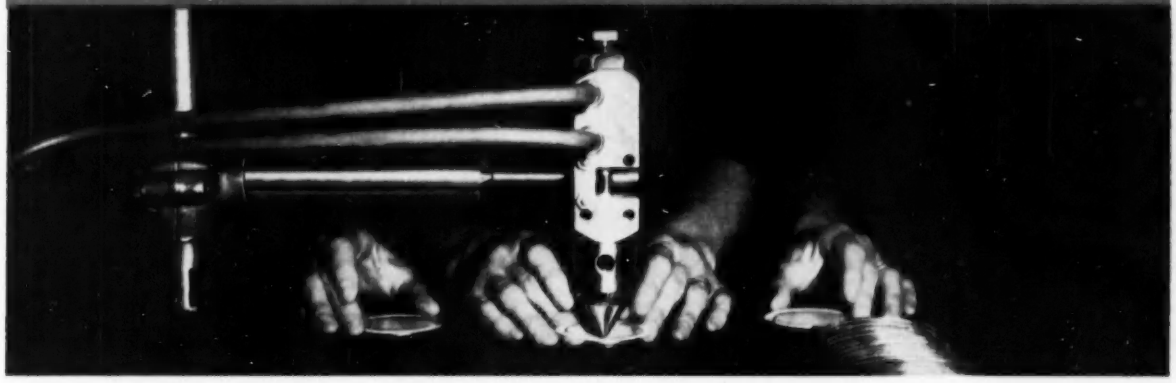

WHEREVER "Flowed-in" gaskets are used, they cut deeply into the cost of hand assembly. If you've ever added up the excessive time, motions and money required in hand assembly of gaskets to your parts, you'll appreciate the "Flowed-in" principle as the outstanding gasket development of the decade.

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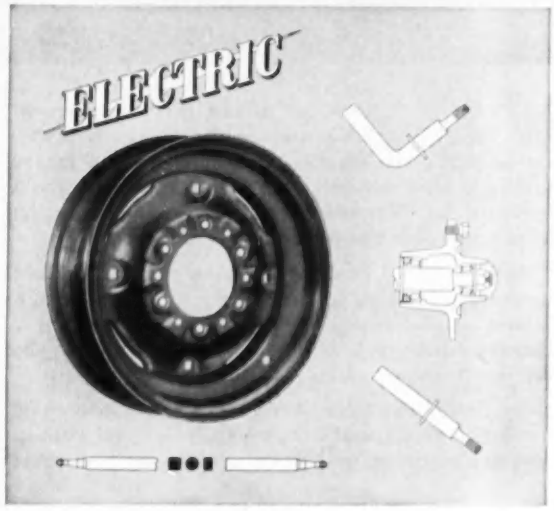

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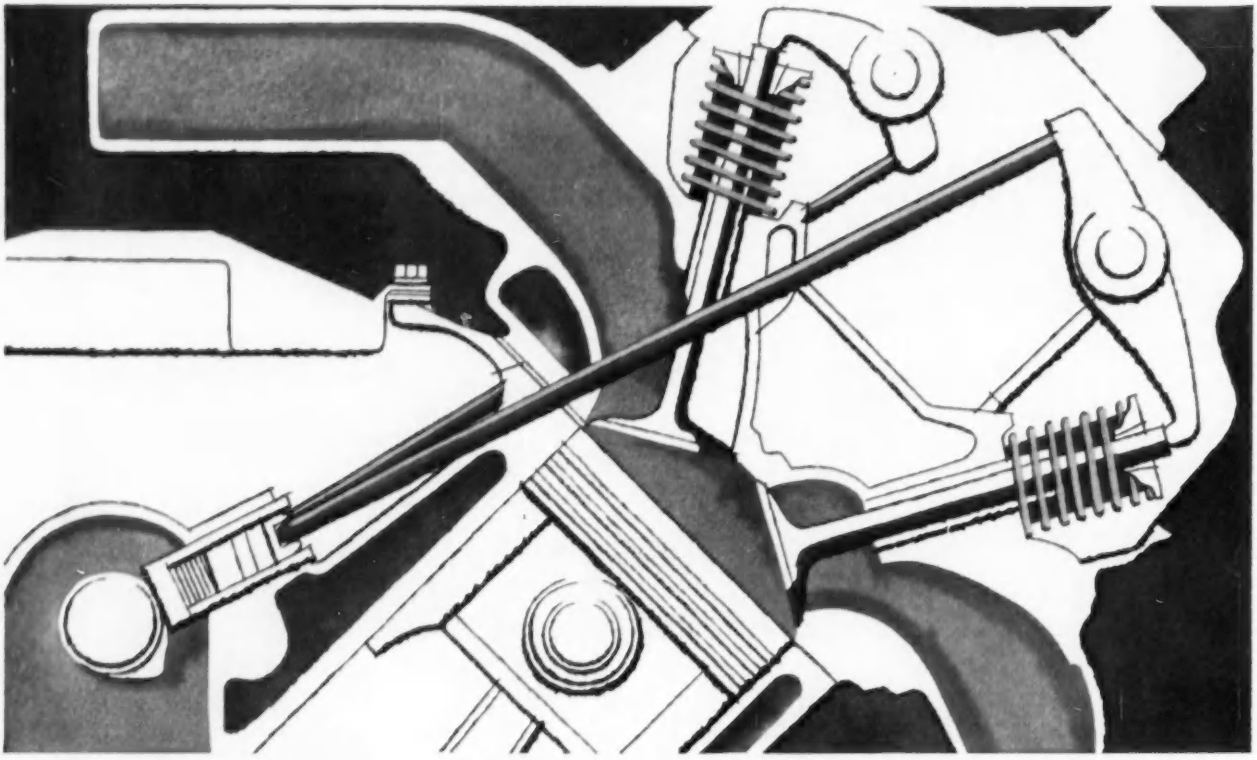
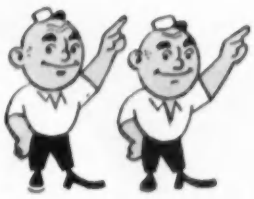


Today's sharp swing toward higher horsepower overhead-type engines for passenger cars has resulted in a steadily growing demand for push rods of Bundyweld, long proved in truck and automobile engines. Let us show you how we can help with your push-rod problem.



How Bundyweld push rods help improve performance of overhead-type engines

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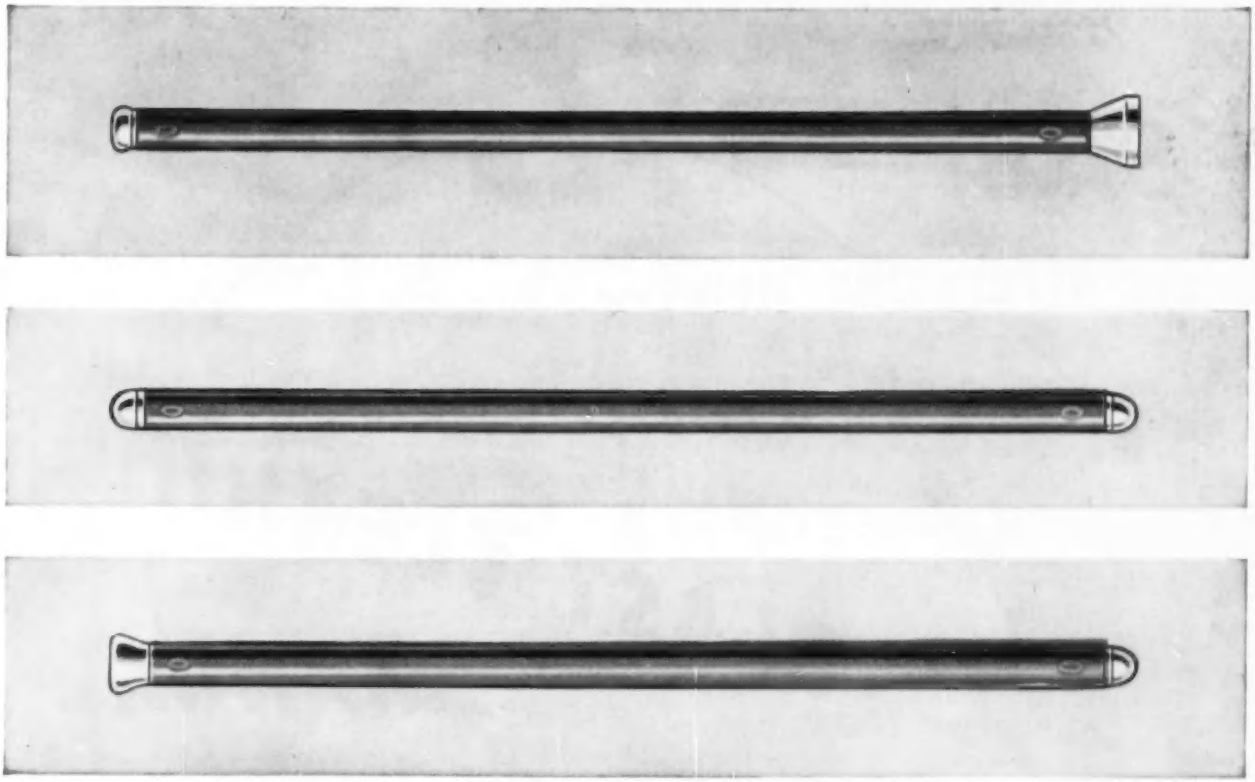
Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.



2 Tough, lightweight push rods of hardened Bundyweld reduce cam load; increase efficient function of entire valve train. Bundyweld fabricates more easily than the material it replaces; results in more uniform, better finished parts. End inserts are easily spot welded to tubing.

Long used in many passenger-car and truck engines, lightweight push rods of Bundyweld have helped design engineers produce more powerful overhead-type engines.

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The tubing: Bundyweld is the only tubing double-walled from a single metal strip, with patented beveled edges. It's SAE 1010 steel, copper-bonded throughout 360° of wall contact into a strong, lightweight, beadless tubing. Wall thickness and concentricity are uniform, accurate. Ultimate tensile strength, yield strength, and fatigue limit are exceptionally high.

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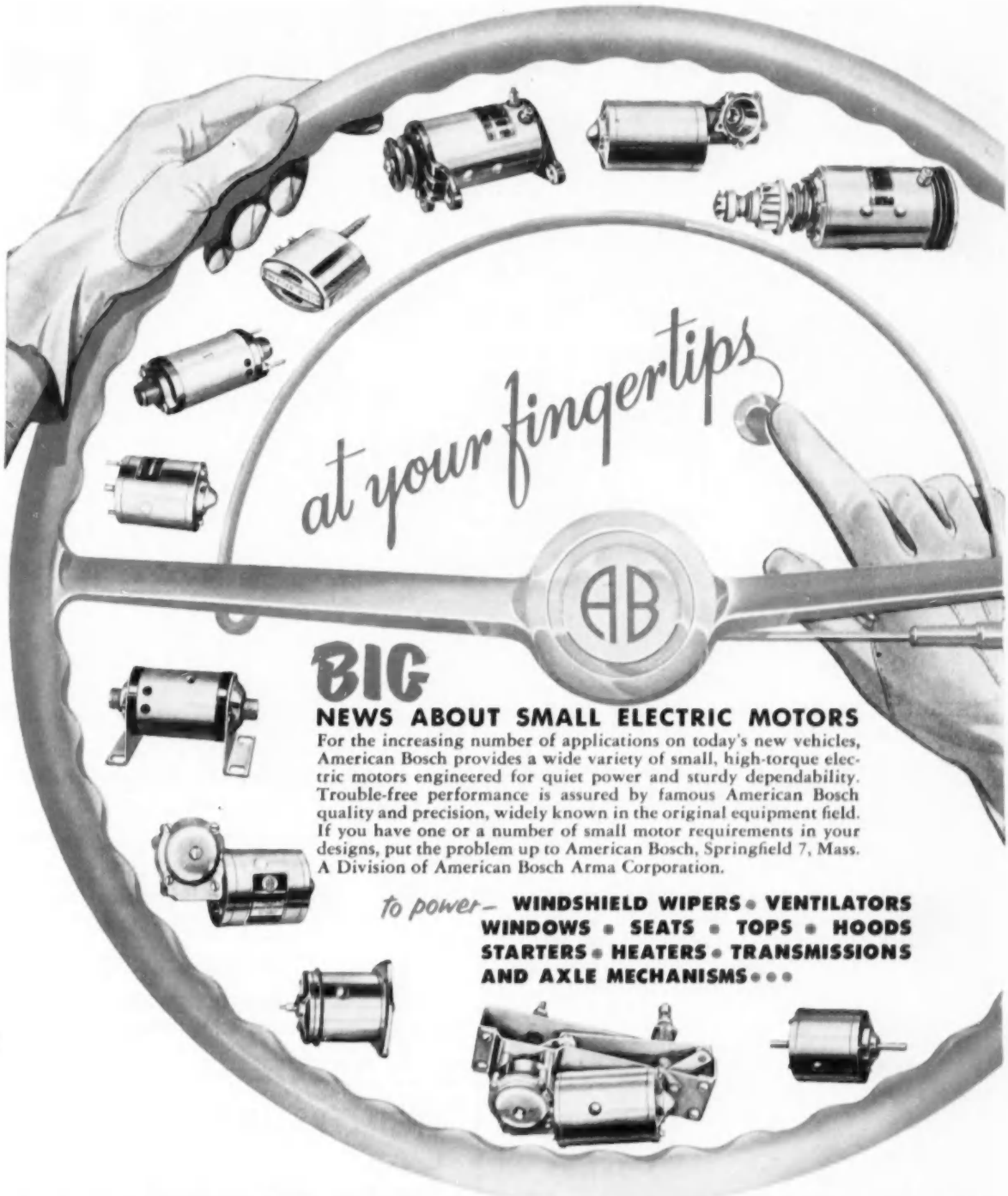

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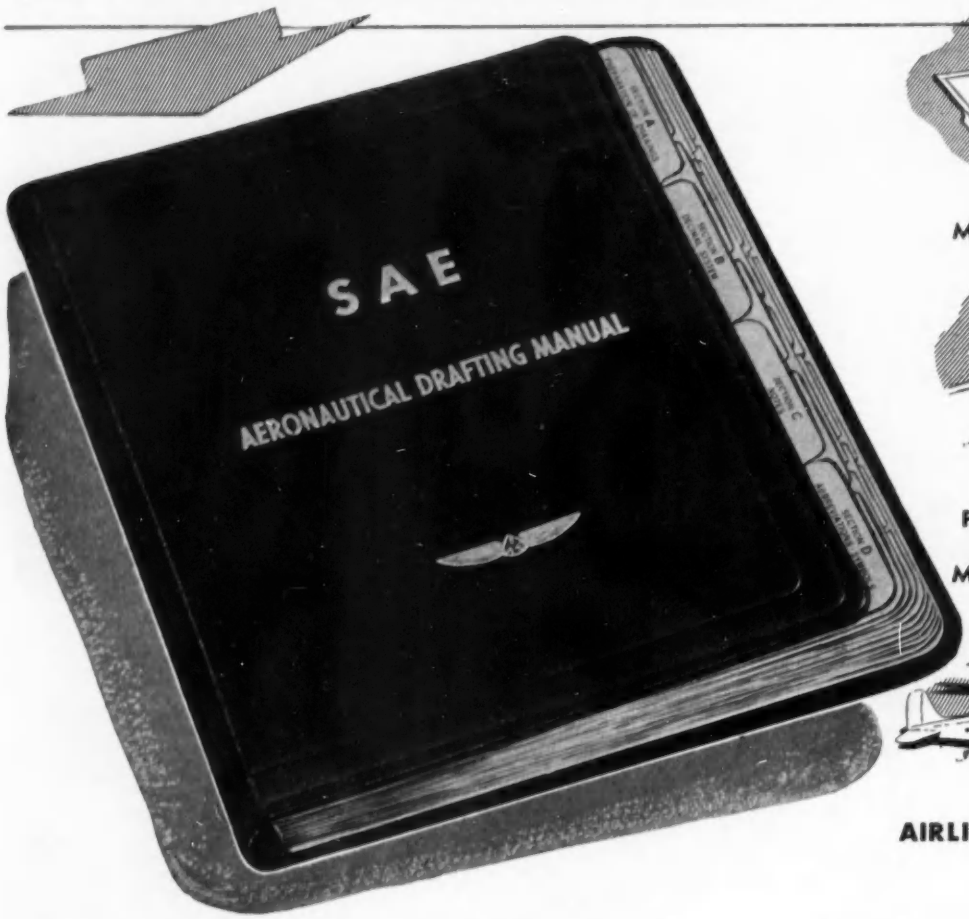

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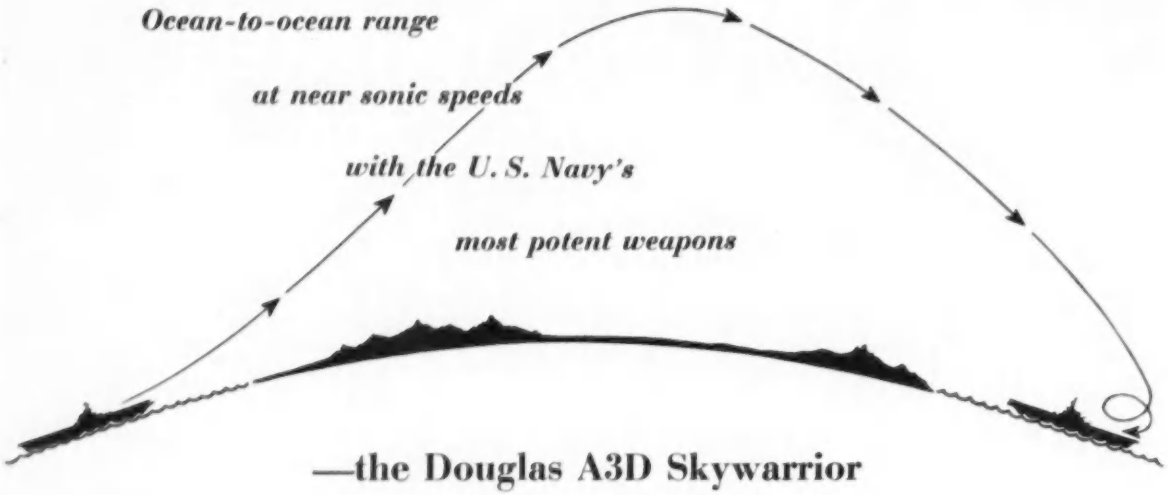

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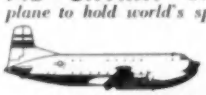

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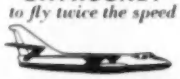

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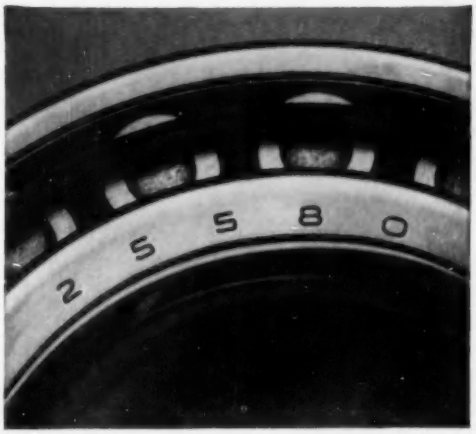

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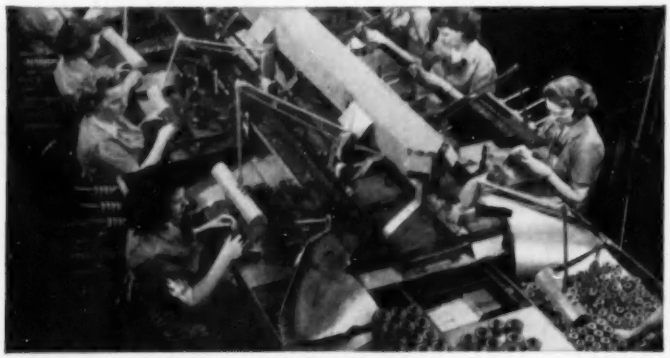

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